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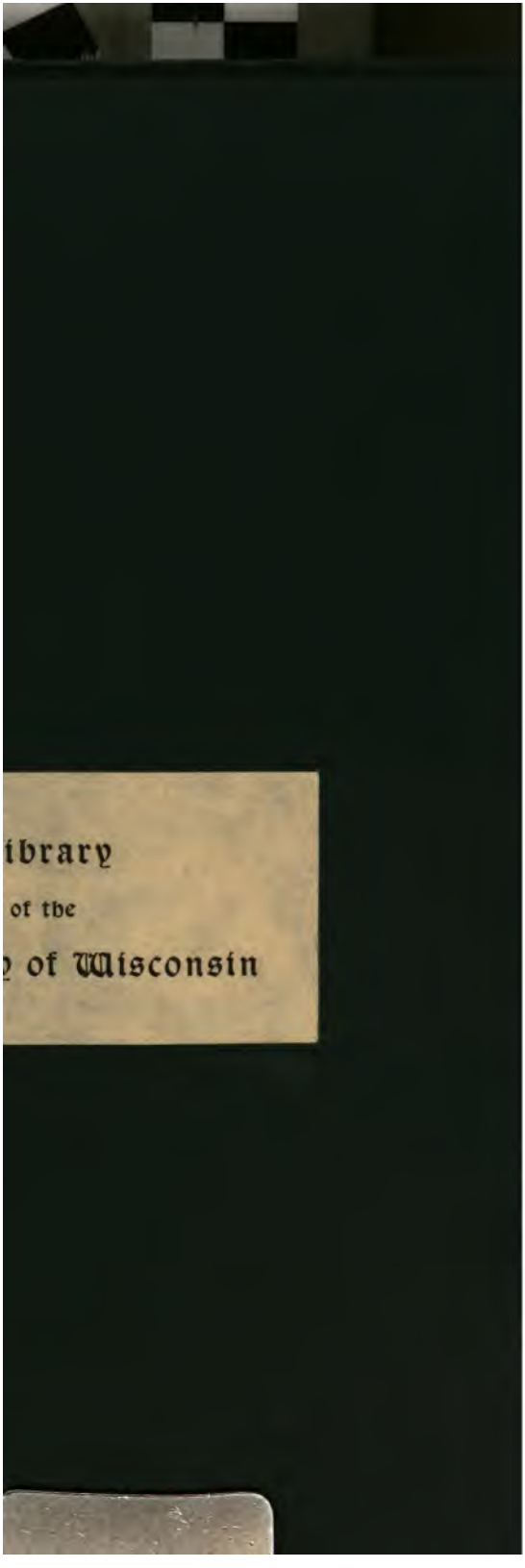
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SANITARY PLUMBING AND DRAINAGE

SANITARY

PLUMBING AND DRAINAGE

BY

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SANITARY PLUMBING AND DRAINAGE.

INTRODUCTION.

IN my opinion, as expressed elsewhere, all plumbing work, if carried out in a proper manner, can be correctly described as "Sanitary Work". In the present day, however, there is a tendency to regard one class of plumbers' work as especially sanitary, and to place the men who are particularly skilful in that class of work on a higher plane than those who are principally engaged in ordinary plumbing work. In some places where the best kinds of plumbing are done, some men are noted as soil pipe hands, because they have acquired more than usual skill in wiping large joints and making bends on soil pipes and large waste pipes; while others are equally skilful in making small joints, and make a neat job of fixing service and main pipes and various other jobs in sheet lead work. In many cases the more experienced men undertake the larger work and the younger men the smaller, the latter generally aspiring to become proficient in the more difficult kinds of work when they have had more practice and experience.

Although there are some parts of the work which undoubtedly require more skill than others, it is not always wise to regard one kind of more importance from a sanitary point of view than the rest of the work of a plumber, because the work in connection with water supply for instance is very

often of far more importance than that relating to the soil pipes and the water-closets.

Not that the importance of plumbers' work which is necessary for carrying out the water carriage system of removing soil and other waste matters can in the least be overestimated, yet of late years there have been many outbreaks of epidemic diseases which go to prove that what is eaten and drunk has been the cause of far more disastrous results than the bad air which is breathed, although it may be poisoned by emanations from drains, cesspools and sewers. In fact,

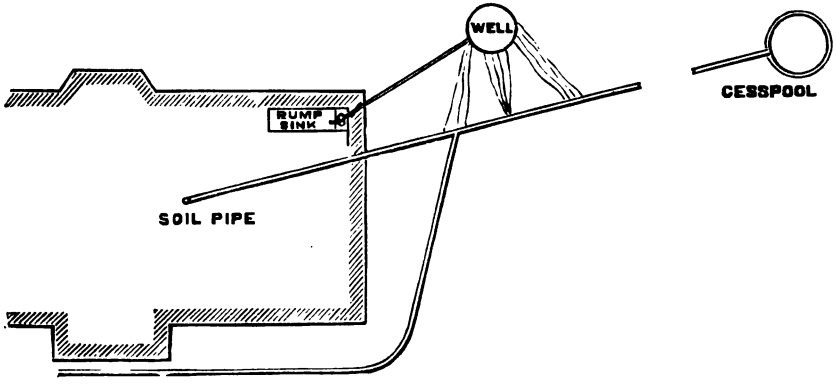


FIG. 1.

if we are to believe the deductions from experiments carried out by some of our scientific men, the old idea of the deadliness of sewer gas is a delusion, for in many cases it is said that the air in the sewer was found to be more pure than that in the public thoroughfare. This no doubt depends, to a very considerable extent, upon the size, use and condition of the sewer, because some of these old-fashioned arrangements have been justly described as "elongated cesspools," and we may of course suppose that the delusion about sewer gas does not apply to cesspools, more particularly the cesspools, or tanks, which are used in the new septic treatment

of sewage, where we are told that the gases generated in the tanks are sufficiently strong to produce light and heat although it may not for all that be of such a character as to produce a specific disease.

It must nevertheless be remembered that there is no doubt about the evils attending the breathing, not only of air contaminated by decomposing soil and waste matters, but even vitiated air, which is sufficient to predispose the persons inhaling it to zymotic and other diseases.

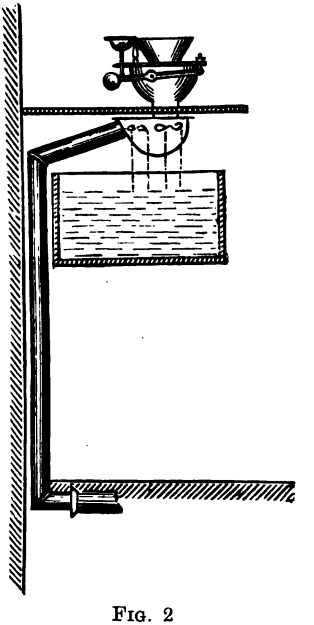


FIG. 2

In many cases, especially in the country, the drainage system, or want of system, and the water supply are so intimately associated that although the work in connection with the soil pipes and closets is as bad as it can be, the water supply is infinitely worse, because the serious defects of the drainage and the method of sewage disposal are rendering the water supply absolutely poisonous and repulsive to think about. Such an arrangement as shown in the sketch at Fig. 1 is a typical one of many which the writer has been called upon to investigate and rearrange. In this instance, the drains, which are constructed of stoneware pipes, were so badly jointed that the sewage leaked out freely and found its way to the drinking-water well, which was situated about eight feet from the line of the drain. And in addition to this serious state of affairs one of the cisterns into which the water from the well was pumped was beneath a water-closet of a very antiquated type, discharging into an old defective D-trap

which leaked some of its contents into the cistern below, as shown at Fig. 2, so that in two cases the water supply was being contaminated by sewage. Now, if it had not been for the improper position of the well in the one case, and the cistern in the other, the probability is that the results would not have been so serious, because the mere leaking of the sewage into the earth outside the house, although bad enough in itself, might have gone on for years without doing much harm. And in the other case, if the cistern did not happen to be directly under the old trap, the leakage would probably have been discovered years before, by the water showing itself through the ceiling. In such instances, therefore, the unfortunate arrangement of the water supply is far more

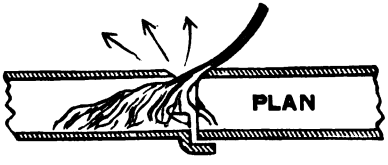


FIG. 3.

serious than the bad drain or the defective D-trap. It may be well to point out that although the joints of the drain in the above case were made with clay and the pipes laid very irregularly, the most defective part of the drain was the result of a root of a tree growing through the clay joint and ultimately forcing the joint apart by the gradual enlargement of the main stem of the root in the manner shown at Fig. 3. Other examples of cases where the water supply and other generally regarded minor matters have been most seriously affected will be given in due course, which will justify my using the term "sanitary" not as relating to any particular part of plumbers' work, but to all branches of the work which are arranged and executed in such a way as to satisfy the requirements of the recognised authorities on modern sanitation.

And although one is well aware that authorities differ to a considerable extent in many cases, it is none the less a fact that many of the wild and eccentric ideas which prevailed a few years ago have been greatly modified, and while the experts must necessarily fail to agree in detail, the main and fundamental principles of practical sanitation are becoming well defined, and are rapidly assuming a concrete form both in this country and on the continent of Europe.

CHAPTER I.

SANITARY SURVEYS.

IN order to appreciate the advantages of the improved methods of carrying out sanitary work, it is well sometimes to point out some of the defects which are so easily overlooked even in works that are being carried out in the present day. In fact it is a most difficult matter in many instances to convince some people of the necessity of many of the improvements which, by those who are familiar with the principles involved, are regarded as absolutely indispensable where sanitary conditions are appreciated. It will therefore doubtless be both instructive and interesting to first of all point out the defects, and then show how they should be remedied or reconstructed as may be found necessary. The first thing then is to find out what is wrong in principle and construction, and explain how my readers should undertake this part of sanitary engineering. During recent years, however, it has become the custom for a class of specialists to undertake this part of the work, to write out the reports and specifications, and to superintend the carrying out of the work. And when the men who undertake this work are properly qualified by practice and experience there can be little fault found with the system.

But when drapers' assistants, solicitors' clerks, and house agents set themselves up as sanitary surveyors, and display as much knowledge about the matter as may be expected from the average office boy, it is, to say the least, rather

annoying to practical men to have to do work in a way which they are quite certain is not reasonable or sensible.

And while there are certain advantages in some cases in employing an independent authority to test, examine and report, it is absolutely necessary that plumbers should be quite competent to undertake the same duties, and there is no reason why in the great majority of instances it should be necessary to call in any other person than a master or journeyman plumber who has made the best use of his opportunities, and acquired the necessary knowledge for making a searching examination and writing out an intelligent report of the existing state of affairs, and a specification of the works which are necessary, from a sanitary point of view, to be done to render the arrangements satisfactory.

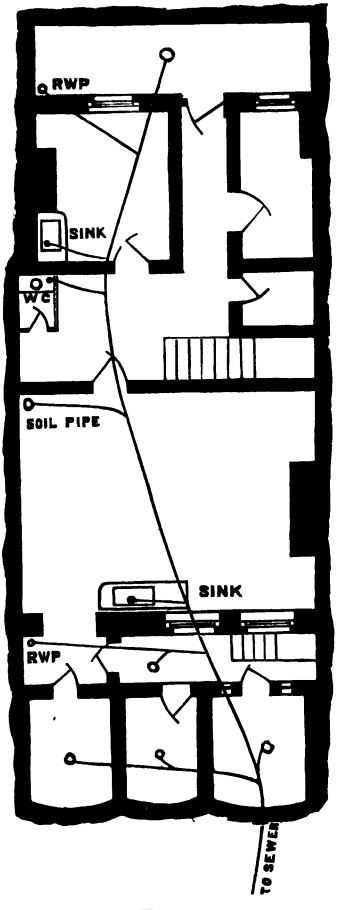


FIG. 4.
Plan of Terrace House showing defective sanitary arrangements.

Now in drafting reports and specifications, one is often asked to use the word "perfect," and to say that if the works are carried out in accordance with the specification that everything will be perfect. But this is a word that one must be careful about in this imperfect world, for although sanitary work may be carried out as near perfection as possible in

accordance with modern ideas, like everything else, whether mechanical or scientific, something is likely to go wrong, either by accident or inattention, and the person who applied the word "perfect" to anything of the kind is very likely to get himself into trouble, as indeed some have already for using terms of much less significance, in connection with sanitary reports. And although sanitary science is very progressive, perfection is far ahead at present; meanwhile, it can give a very good account of itself and can show good results in every direction.

In the first instance, we will suppose that the sanitary arrangements at an ordinary terrace house similar to Fig. 4

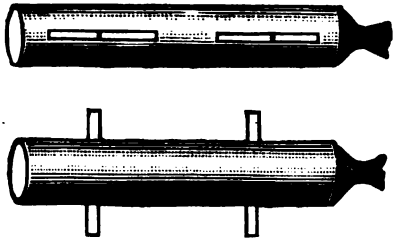


FIG. 5.

are not in a proper condition. There may not perhaps have been any specific disease break out in the house, but the servants and others complain continually of sore throats, headaches, and other minor ailments. The doctor suspects the prevalence of drain air in the house and advises that the sanitary arrangements should be tested and examined. And on arriving on the premises it is evident that there is no means of access to the drains, so that without opening the ground in order to expose the drains it would not be practicable to apply the water test. And although the water test is undoubtedly the most reliable method of ascertaining the soundness of a drain, it is not always really necessary in many cases of this kind, because a much more convenient

test can be applied with sufficient results to indicate the condition of the drain and other pipes in connection with it. And when the smoke test is applied in a satisfactory manner, it very often saves a large amount of trouble and often gives better results than the water test, and which are more convincing to those who do not realise the danger of a drain which does not hold water. There are several ways by which the smoke test is applied; the earliest method probably was to place a smoke rocket in the drain. These are made

FIG. 6.

in the form of the head of a firework rocket (like Fig. 5), and are charged with combustible material which generates a large amount of dense sulphury smoke; and for small sections of drains they often answer their purpose if the defects are very bad; but in large systems of drainage which require careful testing the smoke rocket is not the best thing to make use of. As a case in point the writer had an occasion to test the drains of a house which was used as a ladies' school. It was said that diphtheritic throats were constantly

developing among the pupils, and other symptoms pointed to defective sanitary arrangements. We were informed, however, that the local sanitary inspector had tested the drains on three different occasions, with smoke rockets, and had pronounced the drains to be in good order, and no escape of drain air was discovered. The principal of the school was therefore convinced that although it was thought advisable to get an independent authority to make a test, it was quite certain that as the result of the application of smoke rockets the drains were satisfactory, and the cause of the illnesses was to be looked for elsewhere. But when a smoke machine was connected to the fresh air inlet in the garden, and smoke was pumped into the drains for about half an hour, the basement was filled with smoke, and it could be strongly detected by smell in every room in the house. And this without any special preparation, or even stopping up the ventilating pipes to the soil pipes, although these were only two inches in diameter.

CHAPTER II.

DRAIN TESTING.

FIG. 6 is a sketch of one of the first smoke machines used for testing drains. It consists of an iron hopper in which the combustible material is placed for generating the smoke, and the rotary fan draws the smoke from the hopper and forces it through a tube into the drains.

Although this smoke machine illustrated was considered at one time an excellent contrivance for applying the smoke test to drains, it had one serious defect, and that was, that as soon as the fan stopped revolving the smoke escaped freely from the top of the hopper, and often spoiled a test by charging the surrounding atmosphere with smoke, and thus making it impossible to detect a defect which might have existed near the point where the smoke test is applied. It is of course important that the machine should be connected to a drain as far away from the house as possible, but in many instances when the position of the drain is not known, or it is not convenient to open up the ground, the machine has to be connected to a gully trap near the house. And in the case of a house like the plan shown at Fig. 4, the only suitable place would be to connect the tube to one of the bell traps in the area, where the escape of a large amount of smoke from the machine would be very misleading. Consequently the machine shown at Fig. 6 has been superseded by several others of a much improved form. That shown at Fig. 7, although the first improvement on the one last described, is being used to a very large extent, and is no

doubt one of the best machines in the market for drain testing. It consists of a double-action leather bellows, the centre of which is made to vibrate up and down by means of a cranked lever. The air is forced through a pipe fitted with a stop valve, into a circular copper combustion chamber, which is surrounded with a square copper box to contain water. This may be described as a water jacket, which answers two purposes, one is to keep the combustion chamber cool, and the other to form a water seal into which the cover of the combustion chamber dips, and thus her-

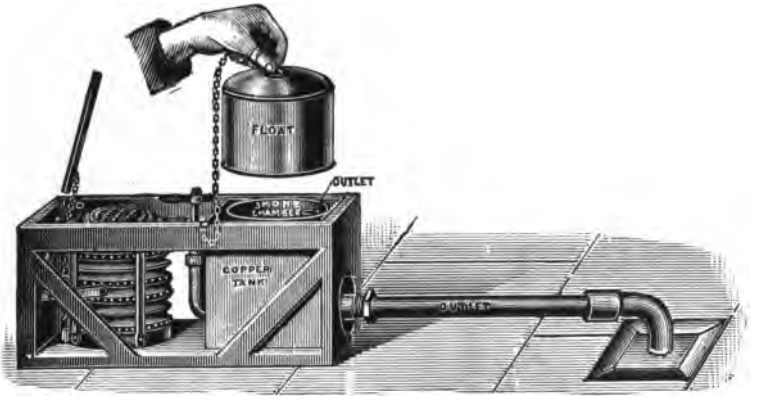


FIG. 7.

metically seals it up and prevents the escape of smoke. Several kinds of material may be used to generate smoke, such as brown paper or rags saturated with oil or similar liquid. As a rule, however, it is found that cotton waste saturated with a common cheap fish oil is the most suitable material for making a dense pungent smoke. It is not absolutely necessary to use combustible materials in the machine, for any volatile oil or essence, such as oil of peppermint or cloves, placed in the combustion chamber, can be forced by the air passing through it into the drains. But such means are not nearly so satisfactory as a dense strong-smelling

smoke, because if a defect only allows a certain smell to escape, whether it is in the drains or soil pipes, it is difficult, if not impossible, to find the exact locality of the defect.

In a house where everything in connection with the sanitary arrangements is obviously bad, it does not so much matter, but when one is testing a house where the work generally is fairly good and only a few minor defects exist, it is a very great advantage to be able to clearly trace

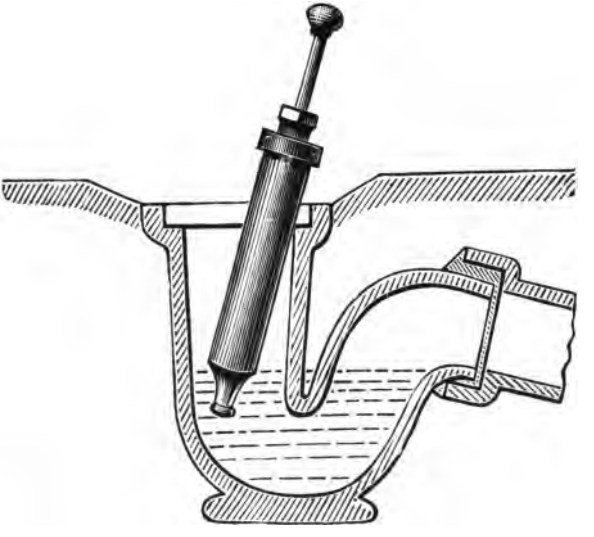


FIG. 8.

the cause of the leakage not only by smell, which is sometimes misleading, but by sight also, which is most convincing. This is why there is very little reliability to be placed in chemical tests which do not produce smoke, such as peppermint, ether, asafœtida, and the like. There are, however, several good chemical tests that may be used with advantage for small sections of drains or when soil pipes have to be tested separately, which will be noticed presently.

The smoke machine has also the advantage of being

suitable for making good to existing arrangements without disturbing the drains or allowing the effluvia to escape. If there happens to be an ordinary gully in the area the water can be either dipped out or removed by means of a small pump in the form of a garden syringe as shown at Fig. 8. And if the gully has a square top, a metal or wooden cover, having a hole in the centre, is made for fitting into the rabbet where the grating rests, and made air-tight with putty or clay. The tube leading from the machine to the gully can either be of flexible rubber or ordinary iron barrel

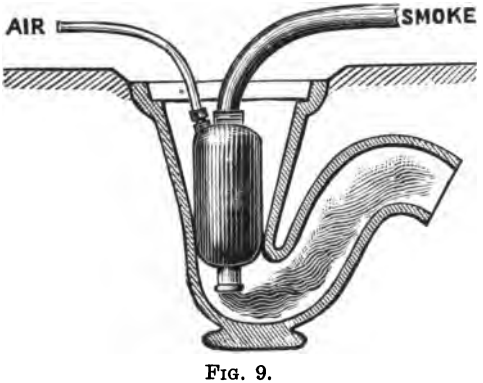


FIG. 9.

with a bend, the end of which is placed through the hole in the cover as shown, and also made air-tight with putty.

If, however, the gully happens to be circular, a much better connection is made with an expanding bag drain stopper as shown at Fig. 9; this is of course much more simple and effective, and the same arrangement can be used in the end of a drain pipe supposing this is possible. But in the case of a bell trap it would be sufficient to place the end of the tube through the centre as shown at Fig. 10, and make it air-tight with putty or clay. It would be scarcely possible to be provided with every requisite for connecting to various forms and sizes of openings into drains, so that

all sorts of means have to be adopted to make the connection temporarily air-tight as long as the machine is at work.

Other forms of smoke-testing machines are shown at Figs. 11 and 12. These are worked on the rotary fan principle, but they are a great improvement on the rotary machine

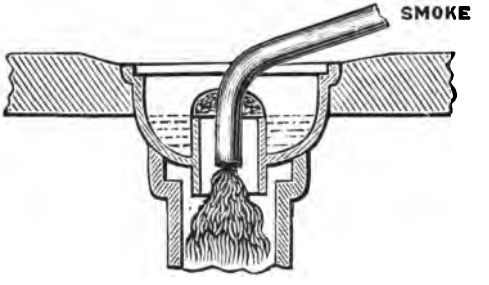


FIG. 10.

already referred to, as the combustion chambers are properly closed so that the smoke cannot escape when the fans are not working. The patentee of the machine Fig. 11 also supplies an expanding stopper, as shown in the sketch, for

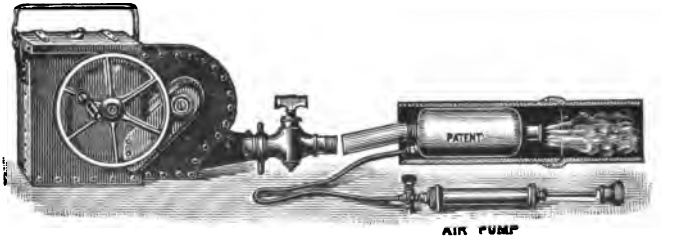


FIG. 11.

connecting the smoke machine either to the end of a drain pipe or to a gully trap which has a circular inlet.

It is often found in old houses that even if the soil pipes are ventilated they are often trapped at the foot, consequently the smoke applied to the drains cannot pass up them, without the drain near the trap being opened up and a hole made

for the purpose of removing the water. This is not however always advisable, because it is generally the best plan to apply the smoke test with as little disturbance of the existing arrangements as possible. It is better therefore to test all trapped soil pipes separately, either by attaching the smoke machine to the top of the ventilating pipe, if there be one. In such cases the expanding stopper with a rubber tube is a very convenient means for making the connection. But where there is no ventilating pipe, or the upper end is in an inaccessible position, other means have to be adopted,

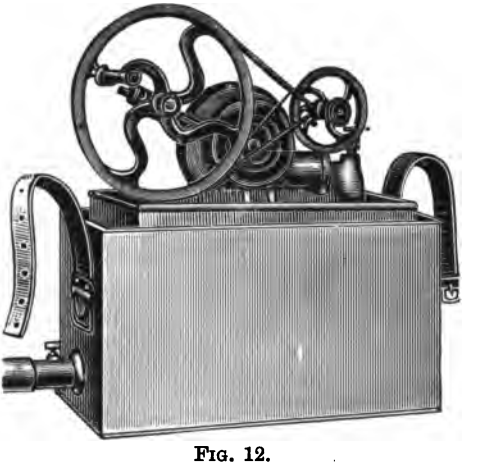


FIG. 12.

and in such cases the various chemical tests are often found very useful. One of the most popular forms of chemical tests consists of a small glass bottle containing a very strong mixture of powdered chemicals as shown at Fig. 13. The bottle is sealed with a rubber cap which is held in its position by means of a tape and a kind of paper binding. A long piece of string is attached to the bottle, so that it can be dropped into a water-closet, and washed through the trap and held suspended in the soil pipe. After a few minutes the paper binding becomes saturated, and by the aid of a

spiral spring, as shown in the sketch, the cap is forced off, and the contents of the bottle are discharged. As soon as the chemical becomes wet, combustion is produced, which gives off a certain amount of smoke and a large volume of very pungent smell.

The advantage of this test over the old-fashioned peppermint test is that no smell is produced until the contents are discharged into the soil pipe, providing, of course, that care is taken to wash the test through the trap before it has time to discharge. One or two of these tests put through a water-

FIG. 13.

FIG. 14.

closet on a trapped soil pipe will be found very effectual in finding any leakages which might exist. A pail or two of hot water thrown down the water-closet after the test is washed through will often make the test more powerful. The practice of emptying a bottle of essence of peppermint down a water-closet and washing it through with hot water is generally very misleading, because so much of the effluvia escapes into the water-closet apartment and to other parts of the house. The peppermint and other tests can, however, be effectually applied through water-closets by means of

the ingenious arrangement shown at Fig. 14. This consists of a round wooden ball, about two inches diameter, with grooves and fastenings for holding small sealed glass tubes,

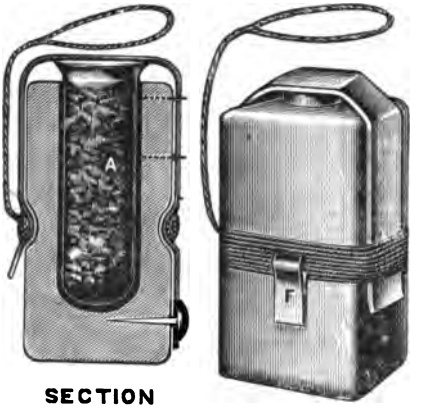


FIG. 15.

containing strong smelling liquids or powders of different kinds. There is also a strong spring and catch fitted to the ball so that when the ball has been washed through the trap

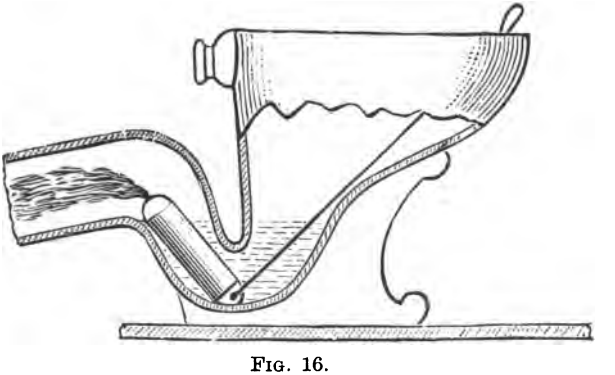


FIG. 16.

of a water-closet, the chord to which it is suspended is pulled with a jerk; this causes the spring to become released, break the glass tube and thus discharge the contents into the soil

pipe. The ball can then be drawn back again for further use. The same inventor introduced a chemical test similar to that shown at Fig. 13, and it is applied in exactly the same way. The bottle in this arrangement, however, is enclosed in a small wooden case as shown at Fig. 15, around which a string binding is wound for holding the rubber band which secures the stopper. When it becomes wet the binding is released and the contents are discharged.

Another very useful test consists of a small rocket, which is made of such a shape and form as to enable one to pass through the water of a closet trap or gully as shown at Fig. 16. The peculiarity of this rocket is that the water in the trap need not be removed, for after it is lighted it can be passed through the water without any fear of putting it out.

It generates a very large amount of smoke for such a small rocket, and the smell is very strong and searching. The disadvantage, however, is that as it has to be lighted in the closet apartment a certain amount of smell is sure to escape before it can be put through the trap.

CHAPTER III.

DRAIN TESTING WITH SMOKE.

HITHERTO we have supposed that an open area exists where the smoke machine can be attached to an outside gully so that the smoke from the machine, which must be opened occasionally for recharging, can be kept out of the house. In some cases, however, one has to test drains under a block of offices or a warehouse in the City, where there are no open areas and where there are no gullies in the open air. And if it should happen to be a very old system of drains, and the soil pipes are trapped or unventilated, it is a very difficult matter indeed to apply the smoke machine satisfactorily. But it is very rarely now that one finds a building without at least a small vent pipe to one of the soil pipes to which the smoke machine can be attached at its upper end on the roof.

In a case of this kind if a trap should exist at the foot of the soil pipe it can be opened, the water removed, and the hole temporarily made good, necessary precautions of course being made to prevent the closets being used while the testing is in progress. In some cases this mode of testing drains and soil pipes is more effectual than by the application of the smoke test at the basement level. One advantage is that the machine is well out of the way and not likely to be misleading owing to the escape of smoke in a close area where some defect might exist which may probably be overlooked on account of the machine being so near the defective part.

There are also some defects in water-closets which are

fixed at the upper part of the house that would probably not be detected by the smoke test being put in at the lower end of the drain, but as the vibration of the machine at the top of the ventilating pipe has a similar effect to that of the wind blowing violently across the top, a badly formed trap or insufficient water seal, which becomes useless by a waving action, is often discovered by such means, whereas by the usual method it may not be noticed.

Another very important advantage occurs in a case where the drain is not trapped off from the sewer, or, as one finds

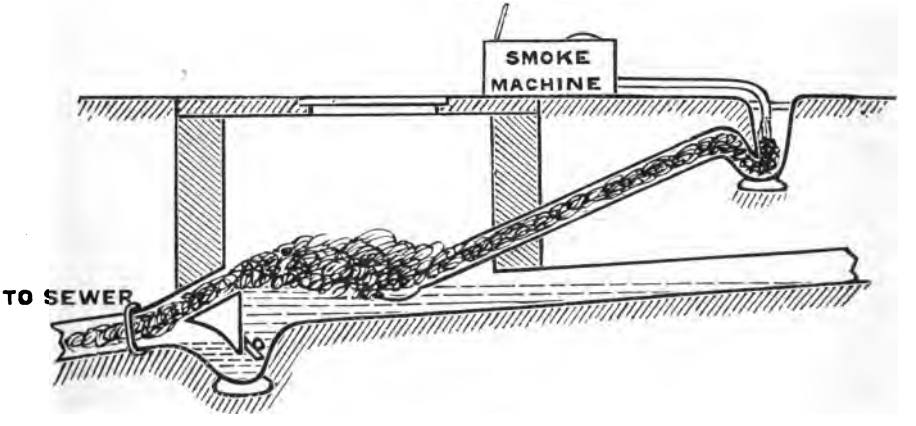


FIG. 17.

in numerous instances, the cleansing stopped on the sewer side of the trap has by some means been removed, with the result that nearly the whole of the smoke finds its way direct to the sewer and out of the lamp holes in the middle of the road. Not that a draught always exists in the direction of the sewer, but in some conditions of the wind and atmosphere the direction of the draught is often reversed. So that in the event of the drain being untrapped and inaccessible except by opening up the ground to a considerable depth if the smoke machine can be attached to the top of the soil

pipe, although no appreciable pressure could be produced it would at least pass through the whole length of the soil pipe and drain and would reveal a very small defect, and a large one would soon be discovered. In the other case, if there is an intercepting trap with a cleansing eye which could become displaced, there would be sure to be a manhole, but in many instances these are covered over below the surface

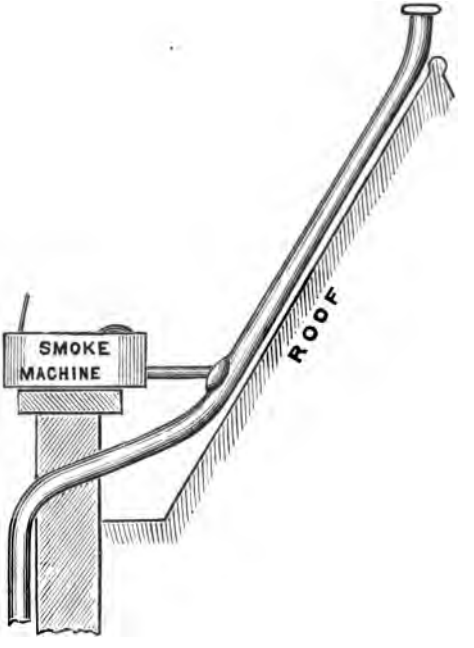


FIG. 18.

where they are difficult to find, so that both cases would be similar.

A case of this kind is shown at Fig 17. A test was being made, and after working the machine for two hours or more, it was wondered why no smoke escaped from the ventilating pipes and no defects were found inside the house, although it was really known that on a former occasion the drains

were not smoke-tight. After some time the water was removed from one of the gullies at the upper part of the drain, but instead of smoke escaping there was a decided draught inwards, showing that the smoke was getting away freely somewhere. But as it was known that a trap was fixed in the drain before it reached the sewer, it was a matter of surprise to see smoke issuing from the ventilating grating to the sewer in the road. On finding the manhole and raising the stone cover it was found that not only was the stopper from the cleansing eye removed but it had dropped into the trap and partially stopped it up, and the sewage was several inches high in the channel and flowing over into the cleansing eye into which also the smoke was found to be passing freely. Now, although the lower end of the drain was partially filled with sewage, if the smoke could have been applied to the top of the ventilating pipe, the test would have been amply sufficient to show the defective condition of the drains and soil pipe with much less disturbance and inconvenience, seeing that the house was occupied at the time. In some instances, where the top of the soil pipe is inaccessible for the machine, it is possible to make a temporary hole at the lower part of the roof and attach the machine in the manner shown at Fig. 18. Or if this cannot be done a long piece of flexible tube is very useful, so that the machine can be placed in a gutter or on a flat and the tube connected to

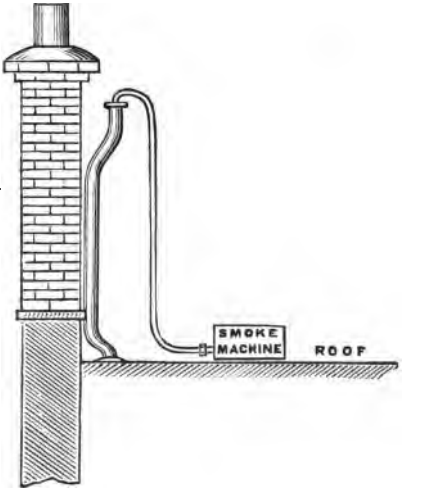


FIG. 19.

the top of the pipe as shown at Fig. 19. The connection can be made either by means of an expanding stopper with a tube through it, as shown at Fig. 20; or, in most cases, if the space around the tube is well packed with cotton waste, of the kind used to charge the machine, it will be sufficiently tight for the purpose. Sometimes the only available place to apply a smoke machine is a basement closet, which is generally in the front vault of a terrace house. In such a case it is a simple matter to remove the water from the trap and make good the tube from the machine, although, so far as the closet and the drain in connection with it is concerned, it may sometimes be misleading, if the smell of the test only is depended on. But as basement closets are often found to be one of the weakest spots in a drainage system, when a defect exists the smoke can be readily seen issuing from the drain or the ground immediately above it. When only a short test is necessary to find the defects, the machine might be charged and lighted in the open before being connected to the trap, and if the cover to the combustion chamber is not removed no smoke would escape into the apartment during the test.

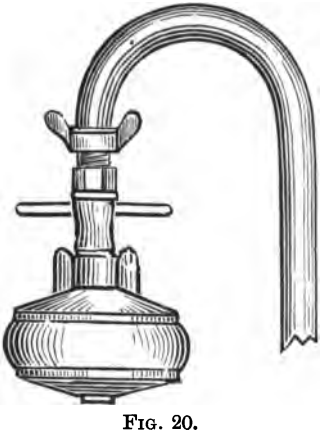


FIG. 20.

CHAPTER IV.

DRAIN TESTING WITH SMOKE—(*Continued*).

HAVING decided upon the kind of smoke machine to use, and the most suitable place for connecting it with the drain or soil pipe according to the circumstances of the case, care should be taken not to disturb any of the existing arrangements more than is possible so that the test may correctly reveal any defects which might exist under ordinary conditions. This is one of the reasons why the smoke test should generally be applied first. If the water test is made use of in the first place, it is necessary to open a manhole or cut a hole in the drain, and in order to fill the drain with water the fittings must be in most cases disturbed, and a larger amount of water will pass through them in a short time than would be required under ordinary circumstances in a week. The result is that otherwise dirty fittings get well washed, and traps, which may in ordinary use lose their water seal, will be recharged, and therefore the smoke test would not reveal the defect. After the machine has been at work a short time and sufficient smoke has been forced into the drains to reach the top of the ventilating pipe, or if there is more than one open pipe, that from which the smoke issues first should be stopped off. This is generally done with a piece of cotton waste, because as a rule it is not necessary to hermetically seal the tops of the ventilating pipes; but if a more severe test is required the pipes can be stopped up by using ordinary expanding drain stoppers, or if these are not at hand a lead or zinc disc

can be let into the top of the pipe and held in position by means of three wires or straps of the same material as the disc as shown at Fig. 21. and the space at the top filled in with soft putty or clay. It must, however, be understood that if the openings are thus sealed up, and there does not happen to be any serious defect in the system, the smoke machine may force the water seal of the traps of the water-closets and produce quite a misleading result. Sometimes what is called an air test is applied to drains and soil pipes. But in cases of this kind all openings, whether they are ventilating pipes or traps to fittings, have to be hermetically sealed, so that a pressure of air greater than an ordinary water seal, of say two inches deep, will resist, can be forced into the pipes by means of an air pump, to the outlet of which is attached a pressure gauge similar to that shown at Fig. 22. If the pipes are air-tight the water in the gauge will stand higher on one side of the U-shaped tube than on the other, and will of course remain in this position until the pressure is released. This is rather a severe test and in many cases very troublesome to apply, and the worst feature about it is that if a small defect exists it is very difficult if not impossible to find exactly where it is. As a matter of fact it is not nearly so reliable as the smoke test, especially if that test is applied by a machine having a chamber which is closed at the top by a bell-shaped cover dipping in a water seal, after the style of the top of a gas-holder; such a machine, for instance, as that already shown at Fig. 7. There is a smoke machine which has a similar principle applied to it, in the form of a pneumatic indicator, having a kind of safety valve at the top which opens and

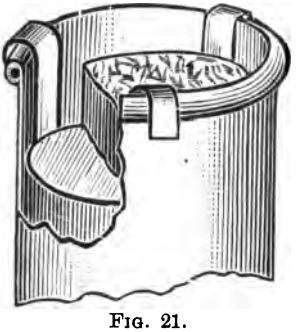


FIG. 21.

releases the pressure when it is nearly sufficient to blow the water seal off the traps.

As a rule, however, it is not necessary to make the tops of the ventilating pipes absolutely air-tight when a reliable form of smoke test is applied, and in order to make it effectual without being unduly severe it should be continued for at least an hour in a small drainage system; but if the drains and soil pipes are extensive the test may be required for

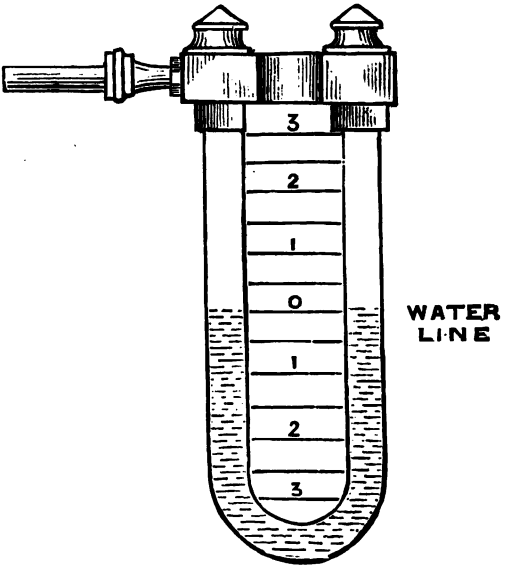


FIG. 22.

several hours. The duration of the test depends, however, upon the state of the pipes, for if they are very bad a very short application of the smoke will be found sufficient to indicate the extent of the defects. That short tests, with rockets for instance, are very often unreliable has been proved in many cases, for it frequently occurs as already shown that the application of the smoke machine has revealed serious defects which the rockets have failed to discover.

If the drains under the ground are very defective, and the ground above them is not close and heavy, like clay or soil of a similar nature, it is not uncommon to get the smoke through three or four feet of earth, and even a concrete surface will not always prevent the escape of smoke. In one case in my own experience, where the whole of the basement floor was covered with a concrete bed and rendered with cement, it was supposed that even if the drains were not sound it was impossible for drain air to find its way through to the house. The drains under the house were, however, found to be so defective that the smoke percolated through three feet of earth, spread out under the concrete bed, and

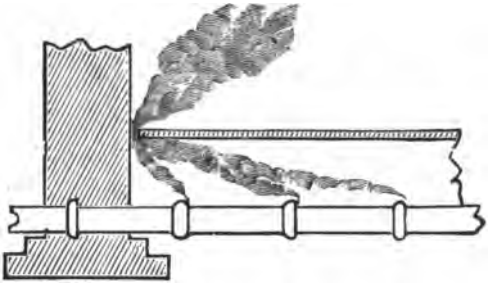


FIG. 23.

then found its way up between the edge of the cement floors and the outside walls, where cracks may very often be found, as shown at Fig. 23. In this way the smoke soon filled the basement, and was not long finding its way to the upper parts of the house; and as the drains in this case were not disconnected from the public sewer it can be quite realised that sewer gases had been having free access to the house, evidence of which had repeatedly showed itself for some years past.

As already stated, a basement water-closet is very frequently found to be a weak spot; in most cases it is the joint between the earthenware trap and the socket of a drain pipe, which, being fixed against the back wall, has a fairly good-

looking joint in the front, but the back has been neglected, owing to the difficulty of getting behind when a space has not been made by cutting out a piece of the brickwork so that the back of the joint can be properly trowelled. A similar defect is often discovered at the foot of a soil pipe, which can be

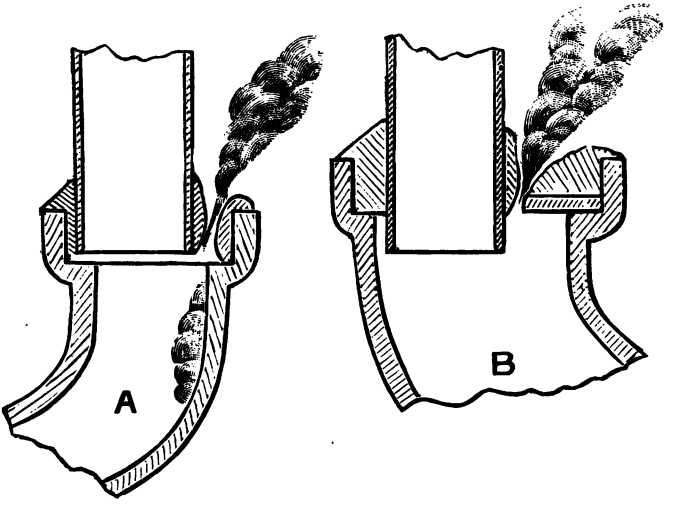


FIG. 24.

attributed to the same cause, and also to the soil pipe not being properly fitted to the socket.

Fig. 24 A and B shows how many of these connections were made, with the result that the cement which should have made the joint sound has fallen into the drain pipe and left a hole for the drain air to escape between the wall and the soil pipe.

CHAPTER V.

DRAIN TESTING WITH SMOKE—(*Continued*).

WITH regard to the various methods adopted for sealing over the upper ends of ventilating pipes while the smoke test is being applied, one of the latest ideas is that of a rubber or skin bag securely tied to the top of the pipe in the manner shown at Fig. 25 A. The principal object in view is to enable one to see when the whole system is fully charged with smoke, as the bag will then be inflated and stand erect as A; but if, after the smoke machine is stopped, the bag collapses as B, it is seen at once that there must be a leakage somewhere. It may, however, be well to point out that this arrangement is very likely to be misleading, because the mere lowering of the temperature of the smoke inside the drains and soil pipes even two or three degrees will produce sufficient contraction of the bulk to enable the bag to collapse. And as smoke is pumped into the system at a necessarily high temperature, the heat will be absorbed, by the drains especially, and a considerable reduction of the space occupied by the smoke will continue to take place for some time. In order, therefore, to obtain reliable results, it would be necessary to charge the system with air only, at as uniform a temperature as possible. And even then it is likely to be as unsatisfactory a test as the air test described in the preceding article. Before proceeding further it may be interesting to call attention to another simple form of smoke machine, which has not yet been used to any great extent in the south of England. The patentee

claims that it is light, compact, thoroughly efficient, and economical. As shown by the section at Fig. 26 A, it consists of a rectangular copper chamber, having a kind of water jacket, in which the cover of the chamber dips several inches. Air is admitted at the bottom by a tube, which is carried up inside nearly to the top of the combustion chamber, and is fitted at the top end with a ball-shaped valve, opening inwards. The outlet for the smoke is near the bottom, and is fitted with an outlet valve and union for attaching an iron pipe or flexible rubber tube. Almost any material may be used for generating smoke, but cotton waste saturated with a little oil is probably the most suitable. When the chamber is charged and lighted, by merely moving the cover up and down, air rushes into the chamber, and smoke is forced out at each down stroke. B shows another form of the same machine.

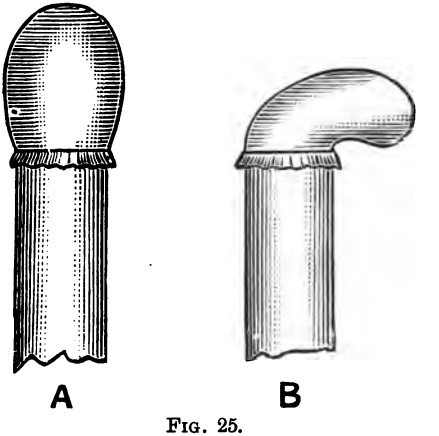


FIG. 25.

Another very common defect which the smoke test reveals, when a reliable machine is used, is the imperfect connection between the branch lead soil pipes and the junctions on iron pipes. These are sometimes buried in walls where they cannot be seen, and, where the brickwork is not properly made good, the air from a leaky joint can find its way freely into the house. As a matter of fact, joints of this kind which are found in a wall are generally unreliable, if not actually open, and they should always be regarded with suspicion.

Fig. 27 is a sketch of a very bad case which the writer had to do with. The lead pipe had evidently been cut too

short, and, as the joint was to be buried in the wall, it was no doubt thought that, by making the brickwork around the pipe solid, the joint would be quite sound, especially as a liberal amount of red lead putty had been applied to the connection. The bottom of the joint had remained water-tight, as no water had escaped to saturate the wall. It would have been better, perhaps, if a leakage had shown itself in this way, for then the defect would have been discovered much sooner. But, as it was, the drain air must have been escaping into the house from the top of the joint for years,

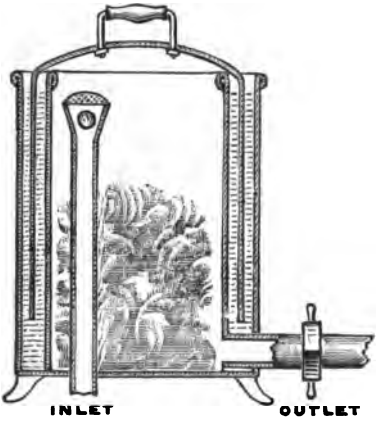


FIG. 26 A.

FIG. 26 B.

as it could never have been sound from the time the house was built. And as the partitions under the closet seat had never been plastered or otherwise made air-tight, there was abundant evidence, both as regards structural defects and the health of the occupants of the house, that the drain air had found its way unobstructed into at least two bedrooms on a floor above, for, after the smoke test had been applied for about half an hour, the smell of smoke in these two rooms was unmistakable. We shall have to deal with the remedies later on, but it may be well to say at once that a

slip joint between lead and iron should never be allowed, and in no case should the joint be built in a wall, but should either be inside or outside, where they can be seen at any time. In addition to the trumpery character of light iron soil pipes generally, a leaky joint may be frequently found where a ventilating pipe passes through the overhanging eaves of a roof, especially where a piece of lead pipe is used for making good through a lead slate. In that way a slip joint is often found between the roof and the eaves, as shown

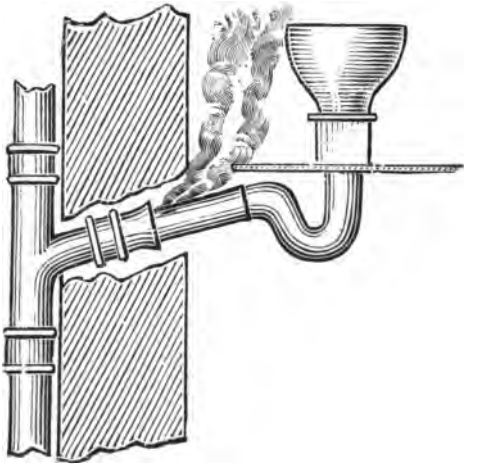


FIG. 27.

at Fig. 28, and in many instances, in my experience, owing, probably, to the awkward position of the joint, no means have been provided to make it air-tight. It frequently happens also that the water cisterns are in the roof on the same side of the house, and probably not fitted with covers, so that the roof space is continually charged with drain air, part of which must be absorbed by the water. In more than one instance one has found the top of the ventilating pipe stopped up by a bird's nest, the only vent, therefore, was the defective joint in the roof space.

The moral, of course, is that joints of this kind should always be avoided in places where they cannot be properly made and where it is difficult to get at them for periodical inspection. And if it is really necessary to use a piece of lead pipe, the joint to the iron pipe should be made below the eaves, where a slight leakage cannot do any harm.

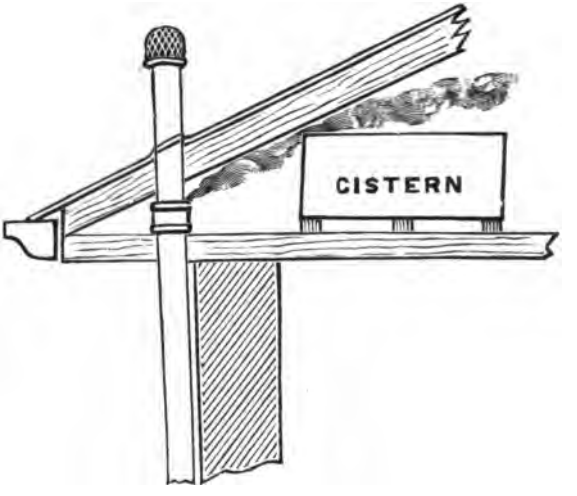


FIG. 28.

The object of the short length of lead pipe is to enable the plumber to make a wiped joint to the lead slate, and this is commendable, but rather than risk a defective joint in the soil pipe it would be better to continue the iron pipe through the roof and make good the lead slate by means of a lead sleeve packed with oil cement. Although if the iron pipe is galvanised there is no reason why the joint should not be soldered.

CHAPTER VI.

DRAIN TESTING WITH WATER.

AFTER the smoke test has been applied to the drains and soil pipes, in the manner already described, and the results noted, it will depend on the effects of the smoke test whether it is necessary to apply the water test. Because if it is found that the drains are so bad that smoke freely escapes from them, and through the ground in which they are buried, it is obvious that the water test is not necessary, for if they will not hold smoke they will certainly not hold water.

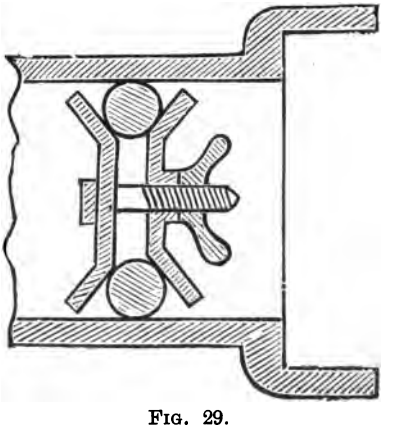


FIG. 29.

In numerous instances, however, it is found that, although the drains are far from water-tight, the surrounding earth is sufficiently dense to prevent the smoke finding its way to the surface.

It is still the opinion of many persons, who profess to be well versed in sanitary matters, that under such conditions, a drain should not be condemned even if it will not hold water. In fact it is often remarked that as a drain is not required to hold water under pressure, in ordinary use, it is therefore subjecting it to an unfair test, which is likely in many instances to render an air-tight drain unsound. The

latter statement is no doubt true in many instances, but it is none the less important that drains which pass under a dwelling house should be above suspicion; and like everything else which is supposed to remain reliable for many years, they should be much stronger than is necessary for the bare and immediate requirements. As a matter of fact old drains are often filled with water when stoppages occur, with the result that a large amount of sewage escapes from the drain to the surrounding earth. And it must also be borne in mind that bad joints in a drain which may not be revealed by an hour or two's smoke test will in time cause the earth beneath to become saturated by sewage, and the earth above it to be charged with drain air, which is being continually breathed out, as it were, by every change of temperature, and poisoning the atmosphere of the house all the year round.

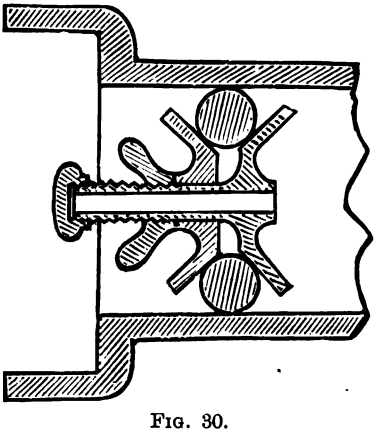


FIG. 30.

Nearly all authorities on the subject are therefore agreed that all drains, whether inside or outside a house, should be substantial enough to hold water, and in testing existing old drains by this test must be decided whether they should be renewed or not. In order to apply this test satisfactorily, if the drains are not accessible, it is necessary to open up and find the drain at its lowest end, so that a stopper of some kind can be inserted.

In the present day there are several kinds of drain stoppers and plugs, which make the water test a very simple matter. But the writer remembers the time when the water test was first applied to drains, and before any special means

were provided for the purpose. All sorts of schemes were then resorted to to form a stopper. It used, to a great extent, to take the form of a lump of clay, and, where this was difficult to obtain, brickwork was built into the drain with plaster of Paris, so that it could be easily cut out after the drain had been tested. On more than one occasion one has used a bag of dry sawdust, and having rammed it tight into the drain, the subsequent swelling of the sawdust by

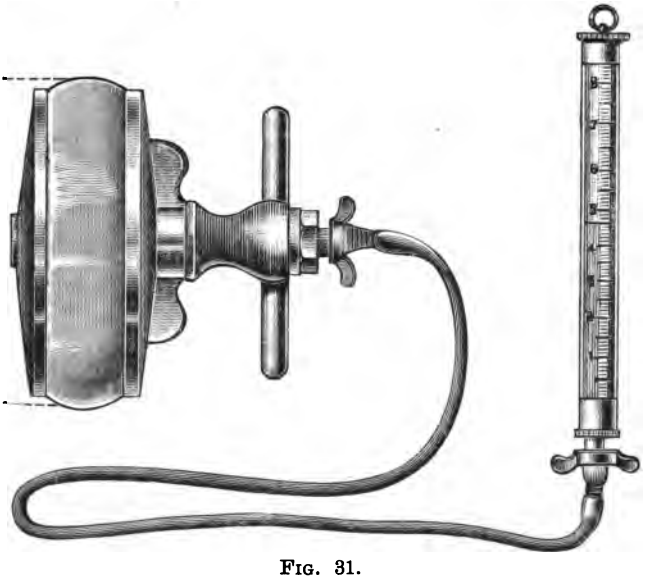


FIG. 31.

the water has made a water-tight stopper. Very often a circular piece of board was fixed into the end of the drain with clay, or plaster, the latter being the more reliable for the short time needed for the test. And although all of these make-shift methods have been superseded, it often occurs that one has to test a drain, and has not always the proper form of stopper to hand just at the time it is required, and it is then convenient to fall back on the rough and ready means which come first to hand.

The simplest form of plug which was first introduced, and on the principle of which most of the existing plugs are still made, is shown at Fig. 29. It consisted of two circular galvanised iron or brass plates with bevelled edges, with a bolt passing through the centres, and a circular indiarubber ring between the bevelled edges of the plates. When the fly nut is screwed tight on to the bolt the rubber ring is pressed outwards to the inside of the drain pipe. This has been improved upon by fixing a tube instead of a bolt

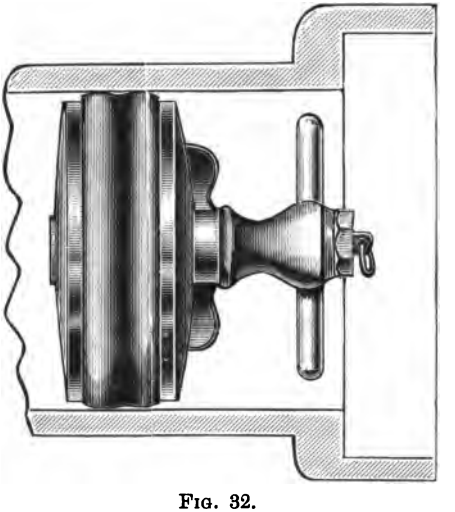


FIG. 32.

through the plates, and placing a screwed cap on the end as shown at Fig. 30, so that a part of the water can be let out, or the whole of it, gradually; whereas, with the original plug, it was necessary to wholly remove it and allow the water to escape with a rush, which is not always desirable when testing new work. This tube is also useful for attaching a rubber tube and gauge or indicator in order to accurately test the soundness of the drain; this arrangement is shown at Fig. 31. Probably the latest improvement in this

kind of plug is shown at Fig. 32. Instead of the rubber ring being circular in section it is in a kind of corrugated form, the object of which is to obtain a greater amount of outward expansion than is possible in a solid circular ring. By this

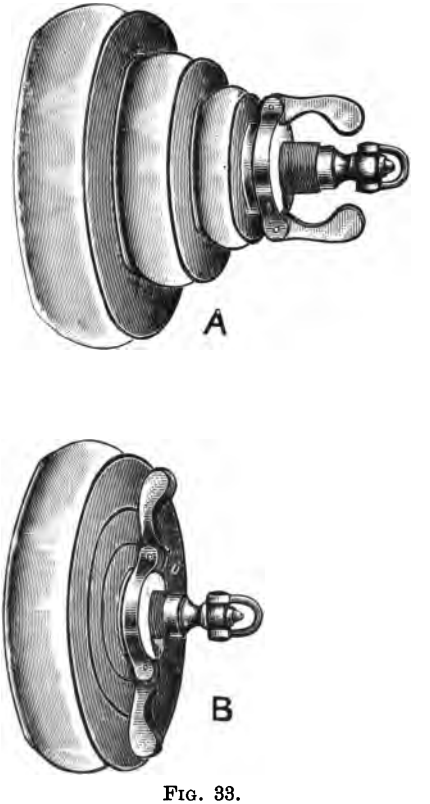


FIG. 33.

means the plug adjusts itself to pipes that vary in size and shape, and is therefore more reliable. A still further novelty is shown at Fig. 33 A; it consists of a combination of two or three plugs equal to four, six and nine-inch diameter, which can be made to occupy the place of one as shown at B.

CHAPTER VII.

DRAIN PLUGS FOR TESTING.

LIKE most of the apparatus in connection with modern sanitary work, the varieties of drain stoppers and plugs are so numerous that too much space would be required to notice every invention which is claimed to be far superior to every other kind in the market. A selection, however, of some of the best and simplest will, no doubt, be useful information to many of my readers. One of the latest expanding plugs is shown at Fig. 34, and although the section shown appears at first sight to be somewhat complicated, the construction is undoubtedly ingenious. It will be noticed that the rubber ring, instead of being round in section, is flat on the outside edge, and so a greater surface is in contact with the inside of the drain pipe. In addition to that, the inside portion of the ring has a feather edge, which is pressed against the inside of the drain pipe by the water pressure, and is likely to adjust itself to any irregularities in the pipe.

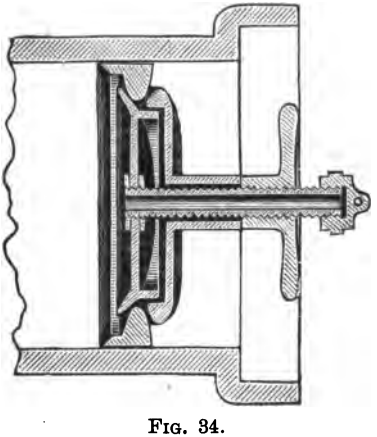


FIG. 34.

Some short time ago a stopper in which the same principle is involved was brought to my notice. This is shown at Fig. 35. Its principal merits are its simplicity and cheap-

ness; but it is certainly not so reliable as one of the expanding stoppers having screws and nuts as already described. It will be seen by the sketch that it merely consists of a disc of brass, a little smaller in diameter than the drain pipe into which it is fitted, and to this is attached an indiarubber cup, similar in shape to a cup leather of a pump. The edge of the rubber cup being reduced to a feather edge, the pressure of the water forces the sides to the drain pipe, and makes it water-tight automatically. There are, however, two brass struts hinged together, and forced into the drain pipe in front of the stopper, as shown in the section, for the purpose of

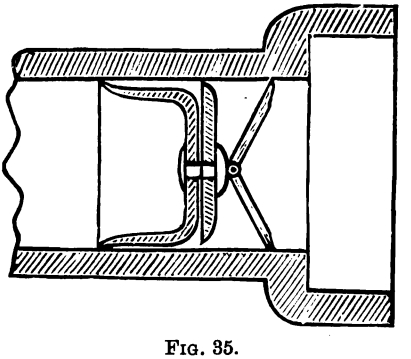


FIG. 35.

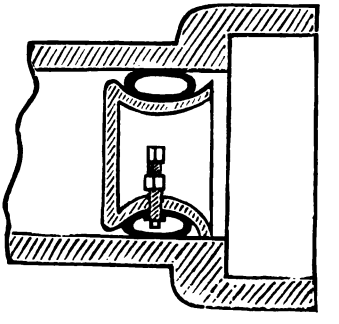


FIG. 36.

preventing the stopper being forced out, because the pressure on the face of the stopper would be greater than the friction on the sides would resist. The very latest idea in drain stoppers is that shown at Fig. 36. It consists of a brass cup, the side of which is hollowed to receive a canvas and rubber tube, which resembles in some measure a bicycle tyre and wheel rim. The inflating valve is, indeed, similar to those on bicycles, and the tube is inflated by a bicycle air pump. It is very difficult, in the case of the four-inch stoppers, to attach a bicycle pump; this could be made more convenient by placing an elbow, looking outwards, on the valve, so that the tube of the air pump could be screwed on more readily.

Although this, like the preceding stopper, is not so substantial as those like Figs. 32, 33, and 34, there is this to be said about them, that since the introduction of many of the three-quarter branch channel pipes in manholes, the simpler kinds of plugs can be used where it is often impossible to make use of one of the stoppers with long stems and fly nuts to them.

In many instances, in my own experience, the absurd shapes to which many of the channels have been made have effectually prevented the use of an ordinary kind of expanding stopper. In the case of old drains and straight pipes which are accessible, there is of course no difficulty; but in some cases it is impossible to use a stopper of any kind, because the end of the drain cannot be reached by the hands,

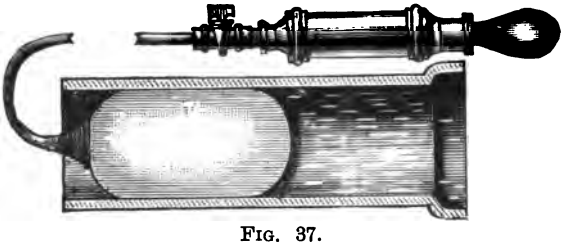


FIG. 37.

and if a stopper could by any means be placed in the end of the pipe, it cannot be screwed up. It is in such cases where the pneumatic bag stoppers, which are now being used to a large extent, are so convenient. These consist, in some cases, of canvas and rubber oblong bags, like Fig. 37, to which are attached a length of small rubber tube, having a stop cock and an air pump for inflating the bag. The bag has therefore to be placed in the end of a drain by some means or other, and made to expand and fit the pipe by means of the air forced into it. This is generally admitted to be one of the most convenient means of stopping drains yet devised. As an instance of their usefulness, which oc-

curred to myself some years ago, soon after they were first introduced into the trade, the following is typical. Having to go some distance into the country to make a sanitary survey of a house the arrangement of which had been modernised in some degree; there was no manhole in connection with the disconnecting trap at the lower end of the drain, but only a shaft leading from the trap to the ground level (like Fig. 38); consequently it was impossible to use an ordinary

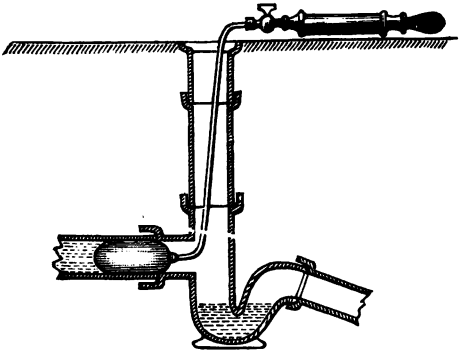


FIG. 38.

stopper, and as there was no reason to suppose that the drains were unsound, it did not seem worth while to open the ground down to the drain, although it would have been very unsatisfactory to have gone back to London without testing the drain with water. Fortunately a pneumatic bag had been brought with the testing apparatus, which, after a little scheming, was pushed into the end of the drain by a broomstick, and then inflated successfully.

CHAPTER VIII.

DRAIN TESTING WITH WATER—(*Continued*).

IT is generally supposed that by the aid of the necessary apparatus the water test can be applied to drains by any inexperienced person, because it is said that any one can tell whether the water remains in the drain or not while it is stopped up at its lower end, and in old systems which are generally defective it may be sufficient to know that the drain will not hold water. But an expert sanitary surveyor would, or at any rate should, soon lose his reputation if his practical knowledge of drains and their many weaknesses was limited to that of being able to watch a water surface in a manhole or drain and to condemn a whole system on that account, as is very frequently done. Like most other practical matters, it is absolutely necessary for one to have a practical knowledge of the construction of drains, both proper and improper, in order to apply the tests in a satisfactory manner.

As an instance of an actual case in point, the following recently occurred. A suburban villa was changing owners, and the new tenant was persuaded by a firm of upholsterers to have the drains and sanitary fittings tested, before the legal matters were settled. Now the drains and sanitary arrangements generally had been renewed about twelve months before under the supervision, not only of the local sanitary authority, but of an acknowledged expert in these matters. However, when the person who was sent to make the survey had fussed about with a smoke rocket or two,

and had filled the drain with water, he reported that the drain leaked very badly as the result of the water test, and a strong smell of smoke was plainly detected in the passage by the side of the house.

He therefore set some one to work to take up the paving and open down to the drain, which was about three feet deep at this point, and well surrounded with concrete. But before

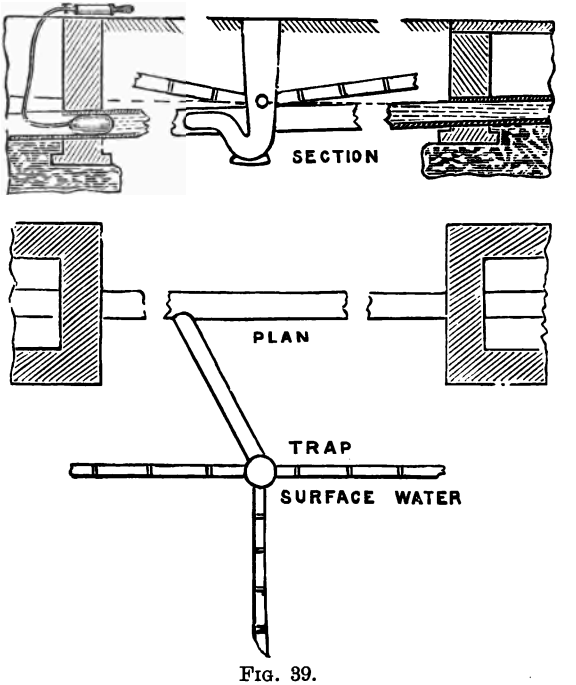


FIG. 39.

too much damage was done some one on behalf of the owner of the house protested against the disturbance until the proper authority was given.

The work of destruction then ceased, and the owner was communicated with. He at once sent for the expert above referred to, and requested him to apply the usual tests in order to ascertain whether the former report of defects was

true, with the result that the whole of the drains and other sanitary arrangements were pronounced to be as sound and good as the day they were finished. And this was shown to be so in the presence of a representative of the firm who gave the false report. And so far as the writer is aware the amateur sanitary surveyor was not enlightened as to the cause which apparently produced an effect which in his judgment was sufficient to justify him in saying the drains were unsound, while as a matter of fact they were as water-tight as a bottle.

It is not my intention in this particular case to state the exact reason why the amateur surveyor was deceived, excepting to say that it was primarily owing to his profound ignor-

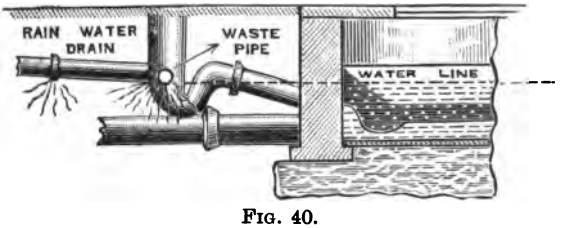


FIG. 40.

ance of drains and the various possible arrangements in connection with them. But I will give an illustration of how something of the kind occurred in another case in order to show how the mistake might have been made in the former instance, although the circumstances were not the same.

Fig. 39 shows a plan and section of an intercepting trap which was fixed for the purpose of receiving the ends of some subsoil soakage water drains, consisting simply of socketless agriculture pipes. Now the side inlets of the trap were considerably below the top of the drain at the upper manhole; the result was that when the lower end of the drain was stopped, and the drain filled with water, it ran back to the

trap and found its way into the ground through the jointless pipes, and consequently the drain could not be filled; it was therefore supposed that the main drain was unsound and required to be opened up, and either repaired or renewed. And, but for the fact that some one who happened to know the existence of the trap was consulted about it, the drain would doubtless have been all opened up and perhaps replaced by a new one.

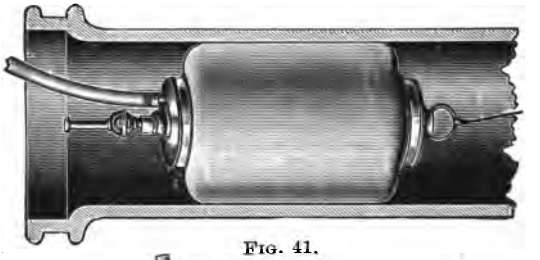


FIG. 41.

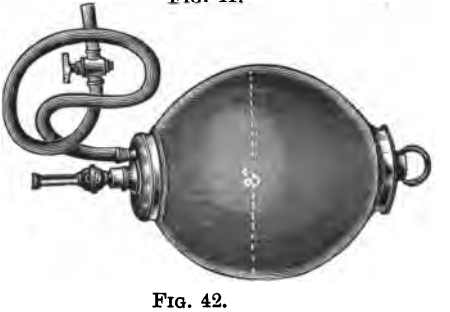


FIG. 42.

Other similar cases occur when a defect exists in the connection of a waste pipe or branch rain-water drain to a gully trap, similar to that shown at Fig. 40. These defects being several inches below the top of the manhole, which is probably filled with water, appear to indicate that the drain itself is leaking, whereas in many cases, although the leak should not of course exist, it is nevertheless of very little importance, but in the absence of practical knowledge is very misleading. It is often very annoying to find that although a drain has

been recently renewed, it leaks somewhere, but the exact spot is difficult to determine. With the object of enabling one to locate the leak, what is known as a search plug has been patented. This consists of a rubber bag having a brass spigot flange at each end and a tube through the centre for the purpose of passing through either smoke or water for testing.

At one end, as shown at Fig. 41, a ring is fixed for attaching a cord, by means of which the plug can be drawn gradually by easy stages through the drain until the position of the leakage is discovered. Then the exact spot can be bared and the necessary repairs executed.

Fig. 42 shows the plug before it is placed in the drain.

CHAPTER IX.

DRAIN TESTING WITH WATER—(*Continued*).

ONE of the difficulties of drain testing is the absence of an adequate supply of water. While there may be in many cases enough water to fill the drain if it happens to be sound, a defective drain will often exhaust the water before it has reached the upper ends of the system where the rate of leakage can be watched. Where a constant supply of water exists there should of course be no difficulty, but in many instances the water supply may be intermittent or temporarily cut off.

In country houses the supply often depends on horse or engine power for pumping the water to the cisterns, and this is not always available just at the time it is required for drain testing. A case occurs to one's mind where a sanitary survey was being made at a country house a long journey from home, and it was important that the results should be known that day. After applying the smoke test and making a thorough survey of the whole of the arrangements, with the exception of applying the water test to a length of drain which passed under the house, it was discovered that the water in the storage cisterns was apparently not sufficient to fill the drain. And as it was getting late in the evening and all the workmen on the estate had gone home, and further pumping was not practicable for that day, the test began to look like a failure.

But on calculating the capacities of the cisterns from which the water had been discharged, and comparing it with the

capacity of the drain which was being tested, it was found that had the drain been sound the water would have filled it three times over, consequently there was no doubt that it leaked very badly.

It will readily be seen therefore that simple methods of calculating the cubic contents of the cisterns and the drains are very useful. The cubic contents of cisterns can be found by calculating the number of cubic feet and multiplying the result by 6¼, which is approximately the number of gallons in a cubic foot. Or the similar result can be obtained by working the calculation in decimals and multiplying by 6·23. As an example suppose there are three cisterns the following sizes—4 feet 6 inches × 3 feet 6 inches × 4 feet deep, 6 feet 6 inches × 3 feet 6 inches × 4 feet 3 inches deep, 3 feet 9 inches × 3 feet 3 inches × 2 feet 6 inches deep. The first is 4·5 × 3·5 × 4 = 63 cubic feet, then 63 × 6·23 = 392·49 gallons.

The second is 6·5 × 3·5 × 4·25 = 96·6875 cubic feet, and 96·6875 × 6·23 = 613·36 gallons. The third is 3·75 × 3·25 × 2·5 32·96875 cubic feet, and multiplied by 6·23 = 205·49 gallons. Then the total contents of the three cisterns is 392·49 + 613·36 + 205·49 = 1211·34 gallons.

Now suppose that the drainage that has been tested with water consists of ninety feet of nine-inch drains, sixty feet of six-inch branches, and seventy feet of four-inch branches. One of the simple methods of finding the contents of circular pipes approximately, which would be quite correct enough for purposes of this kind, is to square the diameter in inches and divide by ten; this will give the gallons per yard run of pipe. Or a more correct method is to square the diameter in inches and multiply by ·034 for gallons per foot run, or if the weight of the water is required, the square of the diameter should be multiplied by ·34 for pounds per foot run. It may be well to call attention to the fact that if the capacity of cylindrical cisterns is required the same rules

apply, providing of course that the diameters are first squared in inches, not in feet.

The contents of the nine-inch drain would therefore be $9 \times 9 = 81 \times \cdot034 = 2\cdot754$ per foot run; this multiplied by the length of drain, thus $2\cdot754 \times 90 = 247\cdot86$ gallons. The six-inch branches work out as follows: $6 \times 6 = 36 \times \cdot034 = 1\cdot224$ gallons per foot run, and $1\cdot224 \times 60 = 73\cdot44$ gallons. The contents of the four-inch pipes is $4 \times 4 = 16 \times \cdot034 = \cdot544$ part of a gallon per foot run and $\cdot544 \times 70 = 38\cdot08$ gallons. The total number of gallons which the drains would hold if sound would therefore be $247\cdot86 + 73\cdot44 + 38\cdot08 = 359\cdot38$. It will be found that the first rule given above gives so nearly the same result that it is quite correct enough for all practical purposes. By the rule used above, a six-inch pipe contains 1·224 gallons per foot, or 3·672 per yard, and by the former rule —*viz.*, $6 \times 6 = 36 = 10 = 3\cdot6$ per yard, which would only make about one and a half gallons difference in the sixty feet of drain pipe in the example above mentioned.

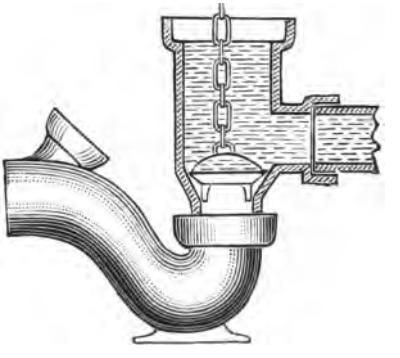


FIG. 43.

Since it has become customary to make periodical water tests, a well-known inventor has patented a drain disconnecting trap, to which is fitted a water-tight stopper in the manner shown at Fig. 43. By such an arrangement the stopper can be dropped into its place without difficulty, and the drain tested as often as it is desired. It is also useful as a means for thoroughly flushing out the trap and drains at regular intervals by allowing the ordinary discharges from the various fittings to accumulate, and then

to discharge the contents of the drains suddenly by lifting the stopper.

By such means a manhole might with more safety be dispensed with, because if the stopper is frequently used the drains will always be kept in good order, and the access to them which a manhole affords will be found unnecessary.

There is one other point about the water test which has not been mentioned, but as it is considered by many persons to be of some importance it may be well to call attention to it. It is the custom of some engineers to insert a tube through the dips of the gully traps in order to allow the air which is

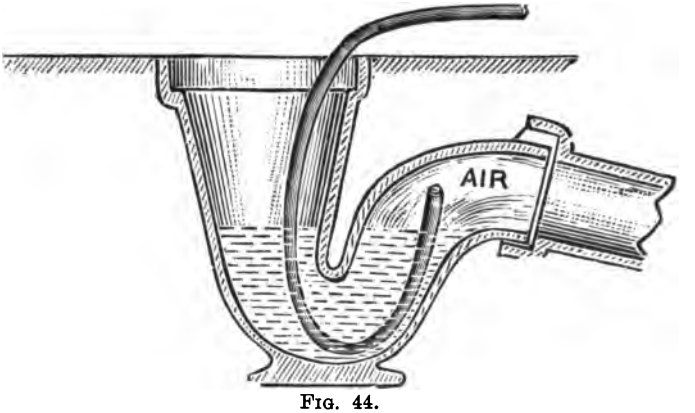


FIG. 44.

imprisoned at the upper ends of the branches to escape, in the manner shown at Fig. 44.

My own opinion, however, is that it is of very little importance, because if the drain will not hold air, it will certainly not hold water, so that if the air remains, water will not escape, and as the volume of air is so small it cannot materially affect the result of the water test. In case, however, of a drain having to be closed at its upper end by a stopper, and being completely filled with air, the large volume of air might make the result misleading. In that case a stopper having a small air tube connection would be an advantage.

CHAPTER X.

SANITARY DEFECTS—CLOSETS.

HAVING described the most reliable tests which are generally applied to sanitary arrangements, the next thing to do is to advise what is best to remedy the defects in the various circumstances; and as it will doubtless be advisable to commence with the simplest arrangements first we will suppose that the drains and sanitary fittings generally in a small villa residence are in a very bad state, which the following description indicates: The main drain is fitted with a running trap similar to that shown at Fig. 45,

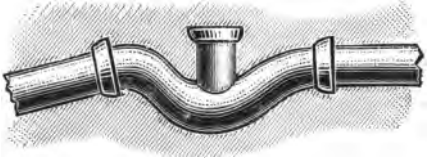


FIG. 45.

which has scarcely any dip, is inaccessible, and is not provided with any means for the admission of fresh air to the drains. Consequently, although the drain can be said to be trapped, or even "intercepted," it is not "disconnected" from the public sewer, because the latter word is intended to convey the idea that, as far as practicable, the house drain should be provided with an airbreak, in addition to a trap, before it reaches the public sewer, and, in order to ensure a current of air passing over the inlet of the trap an air inlet should be arranged so that it will act in conjunction

with a ventilating pipe at the upper end. The drains are found to run irregularly, with bends inserted unnecessarily, and the joints imperfectly made with clay; and, as the pipes are not laid on a concrete bed, the drain has sunk in some

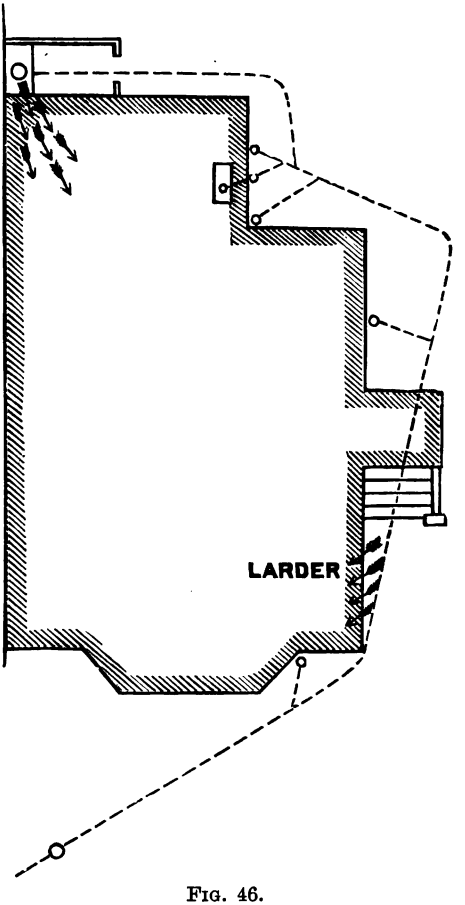


FIG. 46.

places, forming receptacles where sewage accumulates, and periodically causing stoppages. Also, as will be seen by the sketch plan at Fig. 46, although the drain does not actually run under the house, there happens to be a larder close to a

part of the drains that has subsided, and is otherwise very defective. Consequently, not only does the liquid sewage percolate through the ground and the larder wall and floor, but the smoke test shows that the drain gases can easily find their way through the wall, which is not so solid as it should be, to the larder, and from thence to other parts of the house; and, as the running trap is of a kind that frequently stops up, the drains are partly filled with sewage, which forces its way through the leaky joints, and saturates the walls within several feet of the line of the drain.

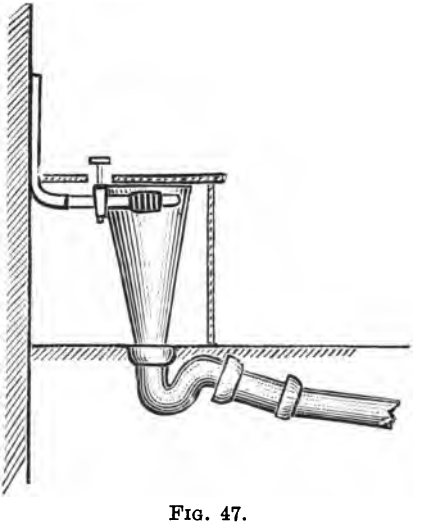


FIG. 47.

The next defect is probably found in the servants' closet. This consists of a long hopper basin and trap without a water seal, similar to that shown at Fig. 47. Smoke is found to escape freely from the drain just below the floor. This may be the result of several bad joints, from which the smoke finds its way along the side of the drain pipes to the surface of the water-closet floor; and as the water supply only consists of a three-quarter pipe and stop valve, or stool cock, under the seat, and the water only spurts through a small slot in the side of the basin, the closet is never adequately flushed. Consequently, the trap and lower part of the basin are very foul, and a stoppage very often takes place, resulting, in many cases in my own experience, in the bottom being knocked out of the trap, and rendering it useless as a barrier to the drain air; and in one instance of this kind

an air brick was found under the seat, communicating with the space under the floor of the house, so that the smell from the defective closet found its way through the air brick to the rooms adjoining. Evidently the water-closet had been built during recent years, and the builder had omitted to stop up the ventilating hole.

The next defect is found to proceed from the surface of the ground around the gully trap, over which the scullery sink waste pipe discharges; and as there was no trap in the waste pipe under the sink, and the temperature outside was considerably lower than that inside the scullery, a draught of air was rushing up the waste pipe, and carrying the smoke from the defective drain with it, so that at first it was supposed that there was some defective drain under the scullery; but when smoke was actually seen issuing from the grating in the sink it had the effect of convincing one person, who hitherto had ridiculed the idea of trapping waste pipes if they were disconnected outside, that, after all, a trap is really necessary, if only to prevent the stink from the gully itself from finding its way up the waste pipe to the lungs of the scullery-maid; so that an arrangement like Fig. 48 must be condemned under any circumstances, for although the channels for receiving the ends of the waste pipes before they reach the gully may in some cases be an improvement, it is only a matter of degree. The soil pipe is the next thing to notice,

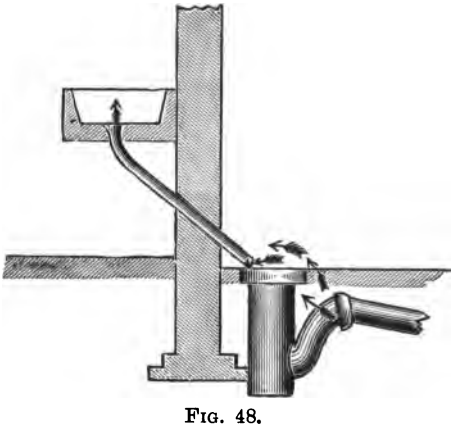


FIG. 48.

because it is, perhaps, constructed of either light iron pipes, with a lead junction and putty joints, or it may be a piece of zinc has been used to repair it in some way, with the result that smoke escapes freely from the joint to the drain, and also from the putty joints above ground, and especially from the joints between the lead junction and iron pipes top and bottom; and as the hole in the brickwork has not been made good substantially around the branch pipe, a strong smell of smoke is noticed in the water-closet apartment upstairs. The smoke was evidently finding its way along by the side of the branch soil pipe, assisted by the draught which was blowing through from the outside.

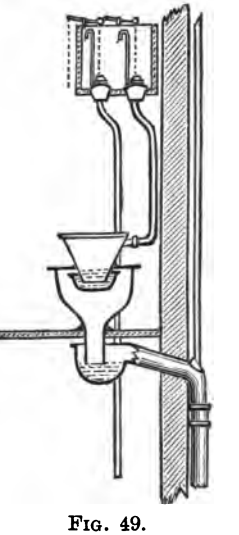


FIG. 49.

This enabled the effluvia from the drain to pass through the hole in the wall, through which the pipe passed to the water-closet; and as it may be assumed that the apparatus was one of the kind known as the "pan closet," that is a large cast iron receiver, in which a copper pan is fixed on an axle, and arranged to hold sufficient water to trap the bottom of the basin, as shown at Fig. 49; and made yet more objectionable by the presence of a large D-trap below it, the cesspool form of which enables it to retain a large amount of filth, with not the slightest probability of its being thoroughly washed out from one year's end to the other; and as the soil pipe may have been in existence some years before the small ventilating pipe was attached to the bend, as shown in the sketch, it is often found in such cases that holes have formed in the top and sides of the D-trap from which the drain air can escape freely. And as the result of the smoke

test, it is evident that drain air has had free access to the space between the ceiling and the floor, and from thence has found its way into adjoining bedrooms, where the smell if not the appearance of the smoke is soon discovered. The next objectionable arrangement will, no doubt, be found in connection with the supply of water to the closet, as this consists of cranks and wires communicating with a round drop valve on a service box in the cistern, which also supplies water to the other fittings in the house; and as there may be generally found an air pipe on the service box, the effluvia from the foul receiver of the water-closet and the D-trap beneath is continually being conveyed up into the water cistern. The very existence of such a combination of defects as described above should, of course, be condemned without the necessity of applying tests of any kind; but it is very difficult in many instances to make people believe there is any danger about it so long as it appears to answer the purpose, and no severe illness breaks out in the house. Unfortunately, there are too many so-called plumbers and sanitary engineers, who pander to the prejudices of their customers, and are content to patch and tinker with these, and even worse arrangements, by occasionally renewing the copper pan, soldering up the holes in the D-trap, and temporarily cleaning the "container" of the apparatus, instead of candidly pointing out the insanitary

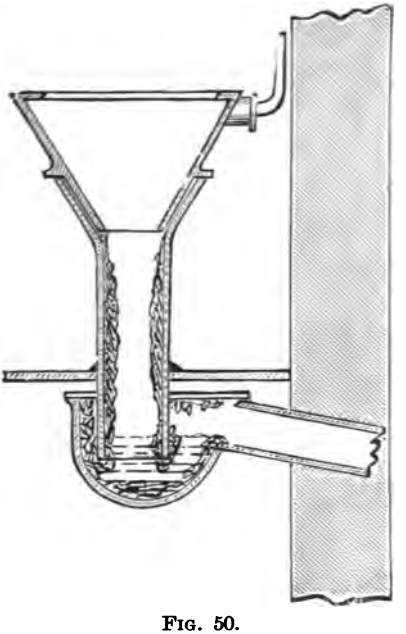


FIG. 50.

character of the whole thing, and advising a reconstruction on modern principles. Some go so far as to defend the old "pan" closet, and argue that the local sanitary authority have no power to compel the renewal of such fittings by some of a modern sanitary kind. This may be so in some instances, but it may be well to point out that the bye-laws made by the London County Council, under the Public Health (London) Act, 1891, the provisions of which are being adopted gradually by other towns, and will, doubtless, become more general throughout the country, state specifically whether in the case of a new construction, or where a person shall newly fit or fix any apparatus in connection with any existing apparatus, he shall furnish such a water-closet with a pan, basin, or other suitable receptacle of non-absorbent material, and of such a shape, of such a capacity, and of such mode of construction as to receive and contain a sufficient quantity of water, and to allow all filth which shall from time to time be deposited in such pan, basin, or receptacle, to fall free of the sides thereof, and directly into the water received and contained in such pan, basin, or receptacle. He shall not construct or fix under such pan, basin, or receptacle, any "container" or other similar fitting.

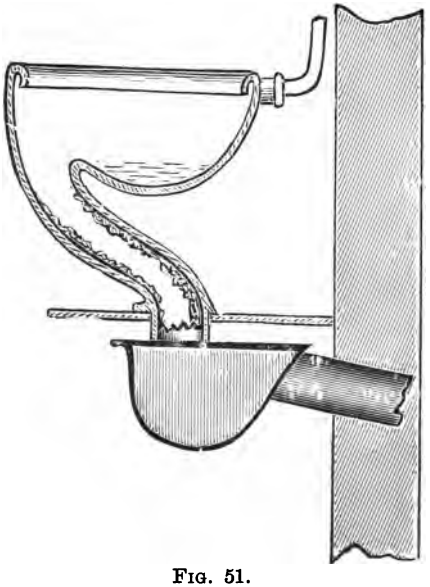


FIG. 51.

Then with regard to the trap, they state that: "He

shall not construct or fix in or in connection with the water-closet apparatus any D-trap or other similar trap ".

It will therefore be noticed that the whole arrangement at Fig. 49 is what is referred to in the above bye-laws. This is, indeed, the principal reason for my using this example as a typical insanitary water-closet. On the ground floor one very often finds what is sometimes regarded as a great improvement, similar to that shown at Fig. 50. It consists of a short basin, very often taken from the pan closet formerly fixed in this position, and connected by a short piece of earthenware or lead pipe to the old D-trap under the floor, which is generally found in the same condition as that described above. The water is supplied by a three-quarter pipe, direct from the cistern on the floor above, by a round valve with a lever and wire pull, and as there is a fan spreader in the basin, the flush is totally inadequate; consequently, not only the basin, but the pipe shaft and the old trap are in a filthy condition. A still worse arrangement is shown at Fig. 51, although this is considered by many people to be the height of perfection. There may possibly be some improvement in the flushing rim of the basin, but this is not sufficient to keep the crooked shaft clean, and what makes it worse is that the foul part cannot be seen, nor can it be kept clean in any way; consequently, the accumulation of foul matter is enormous.

CHAPTER XI.

SANITARY DEFECTS—BATHS AND LAVATORIES.

AFTER noticing the defects in the water-closets and investigating the cause of the leakage of smoke at various points, the next fitting that requires attention is the bath, and although this should be, above all other sanitary fittings, above suspicion, it is very often the most neglected. We shall probably find that it consists of a painted sheet-iron bath, fitted with hot, cold and waste cocks having rods and levers, the services and waste pipe being connected together at the bottom and connected to the bath by one pipe in the manner shown at Fig. 52. Some time ago there was a question in the honours paper of the City and Guilds plumbers' examination to the effect that a bath was fitted up in such a way as enabled the water supply of the house to become contaminated by dirty water from the bath, and asking how the defect should be remedied. To a very large number of the candidates at the examination this was a rather difficult question, because they could not see how the waste water from the bath could find its way into the general service pipes; yet by such an arrangement as that shown at Fig. 52, with the further provision shown at Fig. 53, it is possible to draw water, at the draw-off tap at the sink, highly charged with foul water from the bath. And in the event of a person using the bath who is recovering from some contagious disease the results may be, and there is every reason to believe have been in many cases most serious.

Now by such an arrangement it is possible that when the bath is being used, the cold-water cock may not be quite closed, and as the water enters the bath at the bottom, and the old cocks and levers may be out of order, the fact of the cold water not being shut off would not be noticed. Suppose some one should draw water at the sink just at this time, the rush of water down the main service to the sink would cause the water from the bath to run back and mix with the clean water which is being drawn off.

This would, of course, depend upon whether the main down service pipe was large or small, and it would also depend somewhat on the pressure of water in the pipe. A large pipe with little pressure is not so likely to produce this

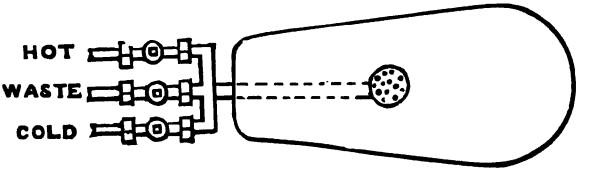


FIG. 52.

result as a small pipe with a good pressure of water. In any case, however, it is decidedly wrong to fit up a bath in the way described, no matter what the arrangement of service pipes may be, because the very fact of the hot or cold water washing back into the bath every time it is used a part of the dirty water, as it always does, is quite sufficient to condemn such an arrangement. It may be well also to point out that much water is wasted by the water supply being connected in such a way as to enable the water to leak away through the waste pipe without being noticed. In several instances in my own experience a great waste of water has been for years going on undetected owing to baths and lavatory basins being connected to the waste and service pipe in this manner. Sometimes, with the object of re-

taining the old-fashioned cocks and levers, the hot and cold branches have been disconnected from the waste pipe at the bottom and arranged to discharge through the side of the bath as shown at Fig. 54 about six inches from the bottom.

This is, of course, an improvement upon the last plan, but it is not entirely satisfactory, because if the cocks are defective and are sometimes not completely shut off, there is

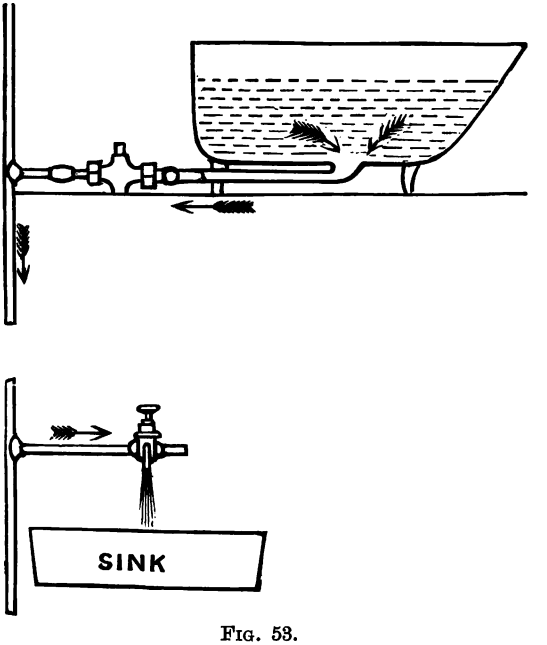


FIG. 53.

still the possibility of drawing dirty water back through the service at a lower level, when the bath is full. In many cases a lavatory basin may be found in the bathroom fitted up in a similar way to that of the bath, sometimes with cocks and levers, but more often with lift-up valves fitted with weights and levers. Although the consequences may not be so serious in the case of an insanitary lavatory, it is not pleasant to know that it is possible to draw drinking water

from a draw-off tap, which water may contain some stale soapsuds in which some persons have washed their hands, no matter whether they were very dirty or comparatively clean.

Yet when attention is called to these and similar defects, and recommendations are made for their removal and something satisfactory put in their place, one is generally regarded

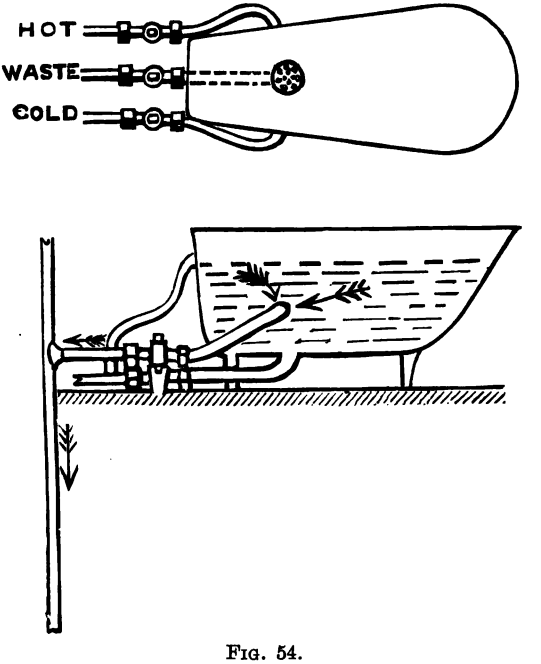


FIG. 54.

as a faddist, because it is said that if the waste pipe discharges over a gully there cannot be much the matter with the bath or lavatory. And as to pointing out the necessity of trapping the waste pipe of the bath close under the fitting, in order to prevent the bathroom being filled by air which is continually rushing through a dirty waste pipe from a foul gully outside, you are generally looked upon as a fussy

person who wants to make unnecessary work and put the house owner to an expense which is nothing but a waste of money.

In addition to the faults already pointed out in connection with the bath supply pipes, the waste pipe will probably be found untrapped, and if it is not connected to the drain or soil pipe it discharges into or near a large form of gully trap which accumulates a large amount of filth from the waste water of a scullery or pantry sink; and, as the overflow pipe from the bath is connected to the waste pipe on the outlet side of the waste cock as shown at Fig. 54, there is nothing to prevent a constant draught up the dirty waste from the gully to the bathroom, with the result that a stale soapy smell, if not worse, is noticed in the bathroom. In the summer time, when the windows are constantly opened, it may not be noticed so much, but during the cold weather, when the air outside the house is much colder than that inside, and the windows are not opened so frequently, there is a continual current of air passing up the waste pipe. The same is of course true in the case of lavatories and sinks, and although in the case of sinks it may not be so objectionable, it is certainly not proper to ventilate an apartment, whether it is a bathroom, pantry, dressing-room, or scullery, through a waste pipe which must of necessity be more or less foul.

Most people nowadays seem to understand that a waste pipe from a bath should not be directly connected to a soil pipe or drain, but if there should be the slightest difficulty in carrying out this idea, all sorts of schemes are resorted to, in order to save trouble and expense, as the following example illustrates. In a town house a bath was situated in the middle of the building and not near an external wall, but a soil pipe was close by into which the bath waste pipe was found to discharge. And as the discharges down the soil pipe were likely to syphon out the contents of an ordinary

round pipe form of trap, a good sized D-trap was placed under the bath and the waste discharge connected to it. It appeared, however, that the person who was responsible for the arrangement had an idea that the D-trap would become somewhat foul in time, and it would not be advisable to connect the overflow pipe with it, as the stirring up of the contents of the trap would cause a smell to escape from the overflow pipe. It was therefore thought better to connect it to the waste pipe beyond the D-trap, as shown at Fig. 55, and fix a round pipe form of trap having rather a deep dip. But how this trap was to retain its water seal seemed to

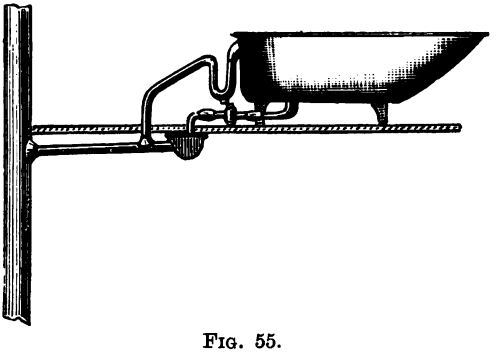


FIG. 55.

have been left out of consideration altogether. For the result was obvious; the water in the overflow trap which was not evaporated was syphoned out sometimes when the bath water was discharged and at other times when the contents of a water-closet was discharged down the soil pipe. And it was only in the rare event of a person filling the bath full enough to overflow that the overflow trap became recharged with water. When this did occur the deep dip of the trap prevented the absolute syphonage every time the bath or the water-closets were used, although if the trap was not recharged during several discharges from the fittings the trap would become almost dry.

Although there was no mistake about a drain smell being frequently noticed in the bathroom, it so happened that when the smoke test was applied to the soil pipe the trap had become recharged, probably by an overflow of the bath water; it was a long while, therefore, before persons could be convinced that the improper arrangements as shown at Fig. 55 were the cause of the mischief. But when a bath full of water had been discharged through the D-trap and the upstairs water-closet discharged twice and the smoke again applied, the volume of smoke which escaped from the overflow was sufficient to prove where the objectionable smells had been coming from.

Another curious arrangement in connection with a lavatory basin is shown at Fig. 56. In this case the waste pipe was taken into the side of a round pipe form of trap under a water-closet, but as it was probably known that when a waste pipe is taken near the bottom of such a trap it very soon gets stopped up with incrustation from the urine, it was therefore placed just below the water line or the outlet side as shown, and, in order to make it quite safe, a trap was fixed in the waste pipe under the basin; it was also evident from a stump with a soldered end on the trap that the overflow from the basin was originally taken into the trap. But for some reason, which is not difficult to surmise, it was cut off and branched into the waste pipe beyond the trap as shown. Before the alteration there can be no doubt that the two traps caused the waste

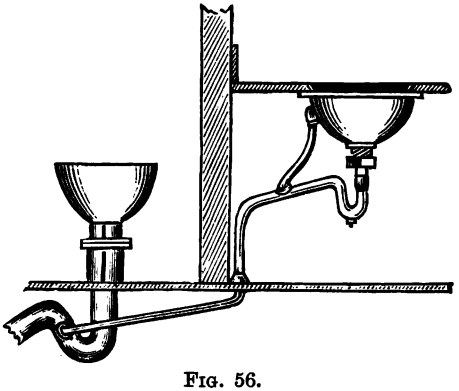


FIG. 56.

pipe to become air-bound, and to all appearances stopped up, which an air pipe through the external wall would have remedied. But the plumber no doubt thought that as the lower end of the waste was below the water line in the water-closet trap, there would be no harm in connecting the overflow with the waste pipe, and thus give it vent. He did not know apparently that some round pipe forms of traps under a valve closet will lose their water seal by the momentum of the discharges passing through them as occurred in this case. So that frequently the water in the water-closet trap was just below the end of the waste pipe, and so allowed the drain air to pass freely up the overflow to the basin, where persons holding their head over the lavatory would get the full benefit of it. This method of rendering a trap useless by branching the overflow into the waste pipe beyond the trap is very common, but when the waste pipe discharges in the open air, it is, of course, not as serious a matter as the instances above cited. But it shows how careful one has to be in investigating the sanitary arrangements of a house, more especially where the fittings have been only partly renewed and the old system of soil pipes and drains readapted.

CHAPTER XII.

HOUSE DRAINS.

IN the preceding chapters some of the most common defects in the sanitary arrangements of a small detached villa, similar to that indicated by the plan shown at Fig. 46 and reproduced at Fig. 57, have been described. It will now be well, perhaps, to point out some of the best methods of reconstructing the drains and rearranging or renewing the sanitary fittings and the plumbing work. With regard to the drainage it was obvious that, however economical one might be inclined, the only satisfactory remedy would be a total renewal of the whole system. But as a drainage system up to date in every respect would involve rather more expense perhaps than could be conveniently borne in a small house with comparatively low rental value, it is sometimes necessary to omit some of the most expensive arrangements. We will, therefore, in this case take an economical view of

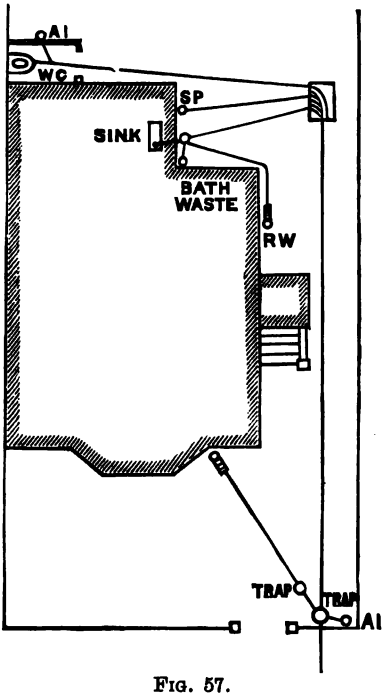


FIG. 57.

the matter, without however impairing the efficiency from a sanitary point of view, and keeping in mind the importance of durability. In the first place the house drain should be disconnected from that in connection with the next house, as the plan at Fig. 46 indicated, and taken in a straight line parallel with the side of the house; and as it is not necessary to pass under any part of the house it should be laid, where practicable, at least three feet from the external walls. In order to dispense with a disconnecting manhole, a very simple but effectual arrangement can be carried out similar to that shown at Fig. 58. This consists of a very ordinary kind of trap; care, however, should be taken to see that it has a sufficient dip or water seal; this should not be less than two inches.

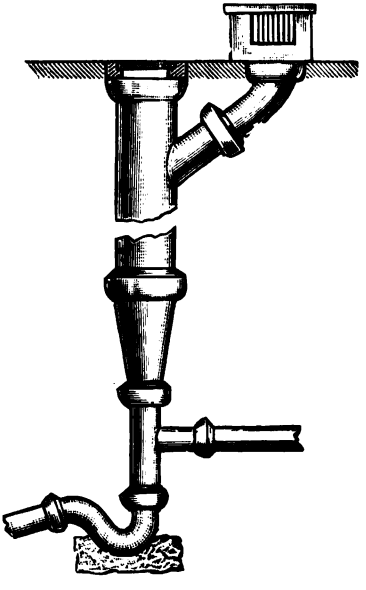


FIG. 58.

A square junction should be cut short and fixed to the inlet of the trap, as shown, for receiving the house drain, and if there is sufficient fall, the higher the outlet of the house drain is kept above the trap the better, because the greater the fall into the trap the less likely is the trap to become stopped up. So important is this that, in my opinion, the necessity for a manhole for giving ready access to the trap is reduced in proportion to the depth of this fall; for if it is possible to obtain a fall of, say, about nine inches in the shaft, the probability of a stoppage in the trap is reduced to an absolute minimum; and as a four-inch drain, if

arranged as shown, is quite large enough, a trap of the small diameter would answer its purpose well.

A taper pipe from four to six inches should then be fixed above the junction, and brought to the surface of the ground. But the plan generally adopted of fixing an open grating at ground level as an air inlet is not a good one, because stones, gravel, sand and other obstructive matters fall down into the trap and stop it up quickly. A better plan is to fix a junction at the upper end of the shaft, as shown, and terminate the air inlet pipe by the side of a wall or fence, either constructing a small brick box with a

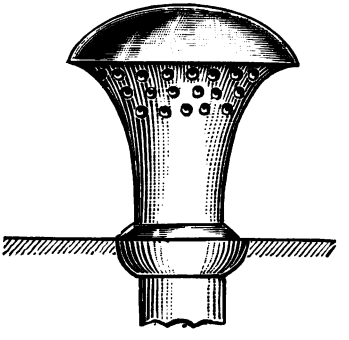


FIG. 59.

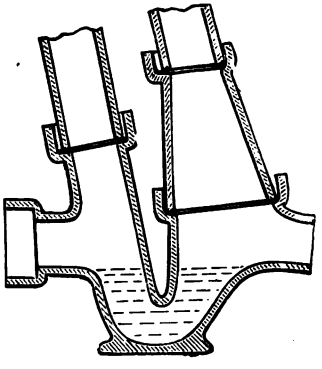


FIG. 60.

grating let in the front, as shown, or, if it is situated in some shrubs, an earthenware mushroom top can be used similar to that shown at Fig. 59. The top of the shaft should then be covered with an iron plate, not necessarily air-tight, let in a stone level with the surface, or, if preferred, just a little above ground level, as shown in the sketch. And if access is required on the outlet side of the trap, a junction can be inserted, and a pipe brought to the surface and there fitted with an air-tight stopper, because, being on the sewer side of the trap, the escape of sewer air would probably be objectionable.

During recent years a special trap has been introduced in order to dispense with manholes. As will be seen by Fig. 60, shafts are brought to the surface from both the inlet and outlet sides of the trap, and a special wide junction is formed on the outlet so that drain rods can be passed down the drain easily. This is a very good arrangement, but, in my opinion, the fall from the house drain to the water line of the trap, as shown, is not sufficient in a trap of this kind where the self-cleansing action is so important. In many

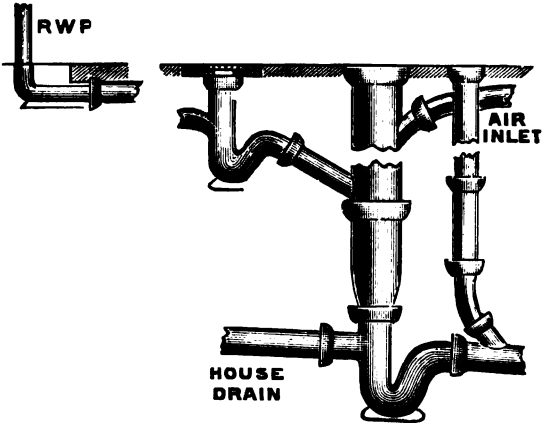


FIG. 61.

cases one finds the air shaft from the trap with one or more bends in it, in order to take it on one side out of a road or pathway, so that in the event of a stoppage it is impossible to get at the trap without opening the ground and removing some of the pipes. This is, of course, a great mistake. When the shaft is quite straight, a stoppage in the trap can generally be removed by simply stirring up the contents of the trap with a long rod, and more particularly with an iron rod having a slight bend which will pass under the dip of the trap. Another advantage of the space between the house drain and the trap is that it can be used as a forcing

shaft in the event of a stoppage occurring in the drain beyond the trap on the sewer side. By such means a most obstinate block in the drain can be forced out.

With regard to the simple form of drain-disconnecting trap, it would probably in most cases be advisable to use one of the many forms of traps which are made with an inlet junction in one piece of earthenware, more especially where a fall of several inches from the house drain to the water line of the trap could not be obtained. Such a trap is shown at Fig. 61, having an access junction on the outlet side, so that rods could be pushed through the drain towards the sewer from the ground level. In this case, also, a junction and trap is shown for receiving the rain-water drain from the front of the house. The object of this is to avoid a long length of unventilated drain in connection with a rain-water pipe, the trap of which is likely to lose its water seal by evaporation in dry weather, and as it is situated under a window, it is sure to be a nuisance. The better plan, therefore, is to fix the trap with an open grating near its junction with the drain, which in this case can be in the shaft, and then a stoneware rain-water shoe can be fixed at the foot of the rain-water pipe, similar to that shown at Fig. 62. This has an open grating for ventilation, and also for giving ready access to the foot of the pipe. Another advantage of treating rain-water pipes in this way is that the trap near the junction is not so near the surface, and therefore more likely to resist evaporation for a longer time, and if it does lose its water seal, the escape of drain air at this point away from the house is not so objectionable. In the event of several rain-water pipes

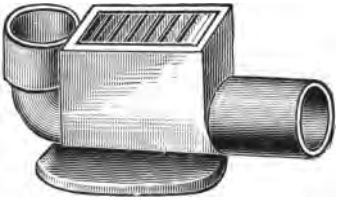


FIG. 62.

being situated where they cannot be discharged into gullies which are kept charged with water from baths, lavatories, etc., it is best to bring them all into one trap, similar to that shown above, and merely fix open shoes at the foot of each of them, an example of which will be given later.

It will be noticed on the drain plan that, as the rain-water pipe at the side of the house is discharged into the gully which also receives the bath waste pipe, only a shoe is required at the foot. The next matter to consider is the laying of the drain. We are supposing in this case that nothing more than good stoneware pipes are required. They should, however, be the kind known as salt glazed, and tested before leaving the works. Most of the manufacturers distinguish these by a T being stencilled on each pipe. They are sub-

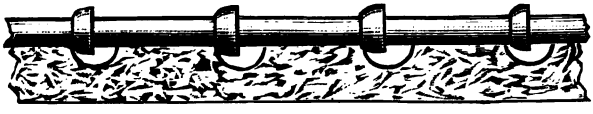


FIG. 63.

jected to an hydraulic test of a much greater pressure than they are likely to receive when they are filled with water after being laid; so that, although the cost is somewhat greater than that of ordinary pipes, it is much more economical to use them when the drain has to withstand a water test. Having determined on the fall to which the drain is to be laid—and this should not be less than one in forty for four-inch pipes—the trench should be excavated, with a fairly straight bottom, and the fall pegged out about every ten feet. It is now a general rule that all drains should be laid on a bed of Portland cement concrete six inches thick, but this, like many other things in sanitary works, depends to a large extent upon circumstances. If the soil beneath has been disturbed, it may be advisable to make the concrete thicker, or if it is hard sand or solid gravel, it may not be necessary

to make it so thick as six inches. In any case, when the concrete is laid first, the upper surface should be quite straight, and where the joints of the pipes have to be made in their place, a hollow space should be formed, in order to enable the joint to be trowelled all round, as shown at Fig. 63. It is not necessary, or, indeed, advisable to make all the joints in the trench, for two, or even three pipes can be stood upright, and the joints made a day or two before they are placed in position; in that case only every one or two joints need be made in the trench. When the trench has a solid bottom the pipes can be laid on bricks, as shown at Fig. 64. The joints are then made, and the concrete care-

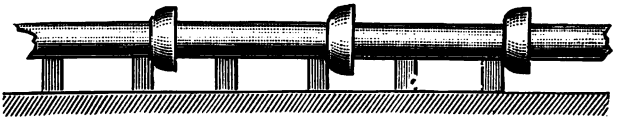


FIG. 64.

fully packed round the pipes afterwards. This method is found to be advantageous when soakage water is continually running down the trenches, as the bricks keep the joints out of the water until the cement is well set. My own opinion, however, is that laying the pipes on a good concrete bed in the first place is more likely to ensure a better foundation, and enable the spigot ends of the pipes to fit concentrically in the sockets, and thus make a better and more reliable drain. It will be noticed that the two plans referred to above do not allow of the old-fashioned style of laying down one pipe, and bedding the next spigot into the socket, and merely trowelling the top of the joint. This sort of work will not do where the water test has to be applied.

CHAPTER XIII.

HOUSE DRAINS—(*Continued*).

AS the system of drainage now under consideration for a small villa residence is supposed to be carried out as economically as possible, the many other more expensive methods of jointing stoneware pipes will not be dealt with at present. It is important, however, that the jointing should be done in the best possible manner, and as a rule it is very little, if any more costly to do it substantially than to joint up the pipes in the slovenly way which is so prevalent among those classes of workmen and others who do not appreciate good work, more especially in drains. There are some who contend that it is impossible to make a permanent cement joint on stoneware drain pipes, because the cement expands and is certain sooner or later to burst the sockets off the pipes.

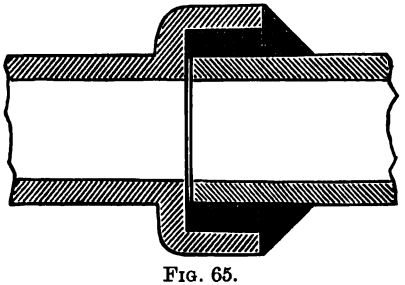


FIG. 65.

While it is true that such an action does occur in comparatively few instances, it is generally the result of carelessness or inexperience. But in most cases in my experience it is the result of employing unskilled labour more for economy than necessity.

Many people have the idea that as it appears such a simple thing to put a piece of cement round a stoneware

pipe joint, and it will soon be covered over and out of sight, any labourer or handy man can do it satisfactorily. But while there may be found during recent years many handy labourers who have gained considerable experience and skill in laying drains, it still does not follow that any one can do it. The most important thing to know is the nature of the materials one uses, especially the Portland cement used for jointing. If the cement is new, and therefore "hot," it is well known to most bricklayers and all who have to do with Portland cement that it expands during setting. Hence its value for underpinning buildings, and ensuring ample support for almost any weight of the buildings above. And if it is used in this condition in stoneware sockets it will in some cases cause fractures. On the other hand, when joints are made with stale cement or some of a bad quality, it will often shrink as it sets and form cracks in the joint, which will leak freely when the water test is applied. Some advise the use of a small proportion of fine sharp sand with the cement in order to prevent the undue expansion, and in many instances this will answer the purpose, but it very often has the same effect as stale cement and causes too much shrinkage. My own experience is that if cement of the best quality is used the heat can easily be reduced by laying it out of the sacks or barrels on a dry floor for a few days so that it may become air slaked, or it can be made quite safe for use if it is mixed with water in the usual way, allowed to partially set, and then wetted and knocked up again, and the same process again repeated when the cement is very hot. A

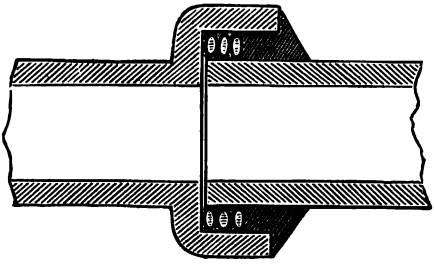


FIG. 66.

very good and reliable method is to fill the socket with cement that has been well "killed," and point up the outside with fairly fresh cement in the manner shown in the section at Fig. 65. This involves two operations to each joint, but as a matter of fact the joints can be made quicker and better this way than by attempting to make them in

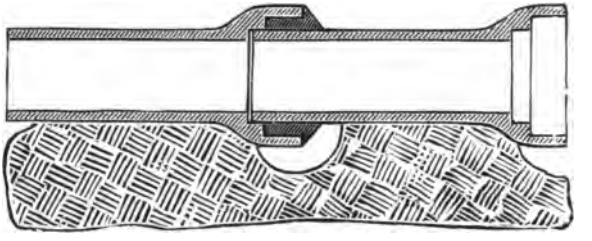


FIG. 67.

one operation, because when the socket is filled and nearly or quite set, the outside fillet adheres more readily and is not so likely to fall off at the bottom, as it very often does when the whole of the cement is put on at once.

It will be noticed that no mention has been made of placing cement at the bottom of the socket and bedding the

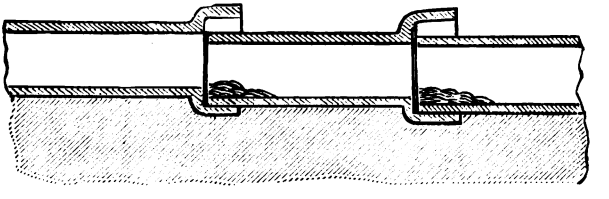


FIG. 68.

spigot end in, and then using a rake or mop to draw out the surplus cement from the inside of the pipes. This method is quite out of date, and quite unnecessary, besides being a very unsatisfactory way of making the joints, because, with all the care possible, when the cement is once allowed to get inside, it is difficult to entirely remove it, and in many in-

stances large portions are left standing up inside the pipes. It was generally supposed that joints could not be made sound by forcing the cement into the sockets from the outside, but this has been found to be a mistake, as nearly all the best class of drain work is now done in this manner. It is sometimes advised that the bottoms of the sockets should be first caulked with tarred yarn, similar to Fig. 66, in order to prevent the sockets being burst off, and to effectually prevent the cement getting inside the pipe. This is not only unnecessary, but the joints are not so substantial, and the yarn, becoming saturated with liquid sewage, tends to pro-

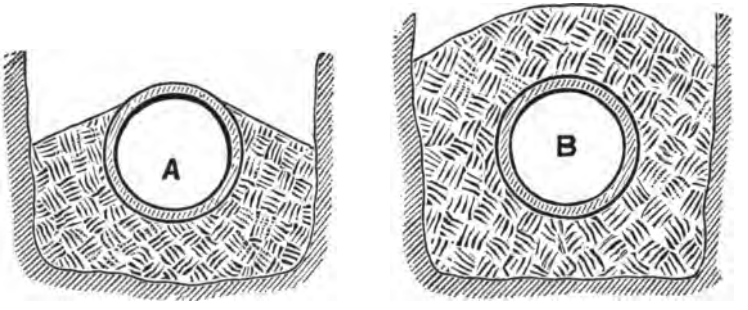


FIG. 69.

duce a much more foul drain than when the whole of the materials are of an impervious nature.

Probably one of the best inventions for the improvement of drain pipe joints is that shown at Fig. 67. It is similar in appearance outside to an ordinary pipe, but it is made with a kind of inner socket into which the spigot end of the next pipe fits without any room to spare. One great advantage is that the spigot and socket is quite concentric, and this avoids the defect shown at Fig. 68, where an obstruction is caused at each joint; although, as already explained, if the concrete bed is properly laid in the first instance, it should not occur when ordinary pipes are used. With this

improved socket it is also impossible with ordinary care to get the cement inside the pipes. After the pipes are laid and the joints made, a reasonable time should be allowed before applying the water test. This, however, depends to a large extent upon the season of the year in which the work is done; for in summer the joints become hard and sound much sooner than they do in winter or during wet weather. In any case the joints should stand at least twelve hours before being tested. Then, as to the concrete covering, when a drain is more than about four feet below the surface, it is not always necessary to cover it with concrete, notwithstanding the fact that most local sanitary authorities insist upon it. For if it has a good concrete bed, it is quite sufficient to bank it up on each side as shown at Fig. 69 A. But when the drain is near the surface, and more especially when heavy traffic has to pass over it, the concrete should surround it to a thickness of at least six inches, as shown at Fig. 69 B. Another precaution to take is that the earth should be replaced lightly until it is about a foot above the concrete, and then the ramming can commence without fear of disturbing the drain.

CHAPTER XIV.

MANHOLES.

IN our drain plan, which is reproduced at Fig. 70, there is only one manhole shown. This is situated at the bend of the main drain, where the branch drains from the soil pipe and scullery sink waste are connected with it. In a small drainage system this is the most suitable position for an inspection manhole, because stoppages are more likely to occur at the junctions than anywhere else. Another advantage is that from this point rods can be passed into the whole of the dirty water drains either for removing stoppages or for periodical cleaning. Like many other parts of a drainage system, however, manholes may defeat their principal object, by being the cause of obstructions instead of tending to prevent them. Frequently one finds during sanitary surveys that owing to improper arrangement and construction manholes have become accumulators of filth, and have been continu-

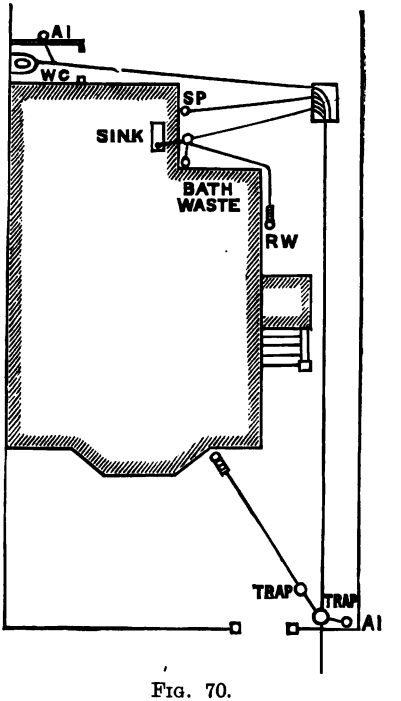


FIG. 70.

ally the cause of stoppages that would in all probability not have occurred if the branch drains had been connected by easy *y*-shaped junctions instead of by a badly formed manhole.

One of the principal objects of modern drainage is to

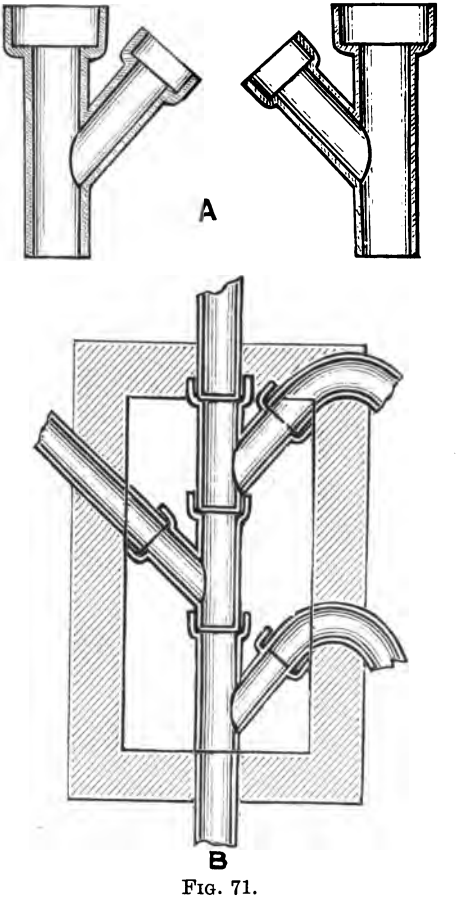


FIG. 71.

render the whole system self-cleansing and prevent the accumulation of solid matters and foul water in any part, but when one finds some manholes very much like small cesspools, there should be no wonder that some people regard

them with a large amount of suspicion; although they are more often objected to on account of the expense they incur. In the first place, when the manhole is built of brickwork, it should have a substantial foundation of cement concrete of about six inches deep, but more or less according to the circumstances of the case. The necessity for this precaution was more than usually impressed upon me just recently, where a house drain was said to be in very good order, with the unimportant exception that the channel in the manhole was cracked. Upon investigation, however, it was found that the lower part of the manhole had sunk down, and not only broken the channel, but the disconnecting trap was fractured and the drain just outside the man hole completely broken apart; the whole drain, in fact, was in a most dilapidated state. The brickwork should not be less than nine inches, and for a manhole not more than five feet deep, one course of footings should be provided. But when the manholes are deep two courses of footings should be laid on the concrete foundation.

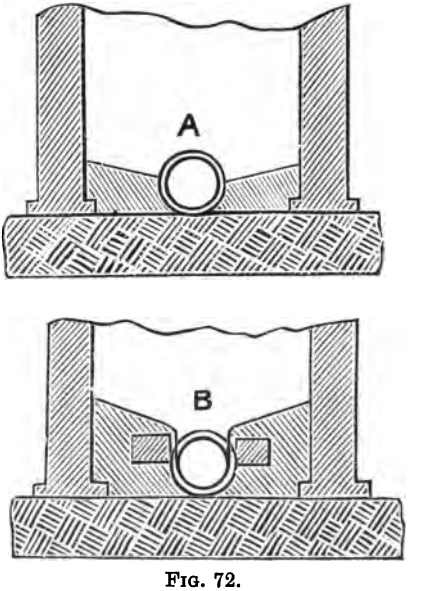


FIG. 72.

The next important matter is the angle at which the branch channels join the main channel. When ordinary brownware channel junctions are used similar to A, Fig. 71, in which the branch channel joins the main channel at the same level, the angle is fairly satisfactory and cannot, of

course, be altered. But in cases where the branch drain approaches the manhole at a right angle, and no proper bend is used, the angle of the junction does not materially affect the direction of the discharge from the branch drain into the

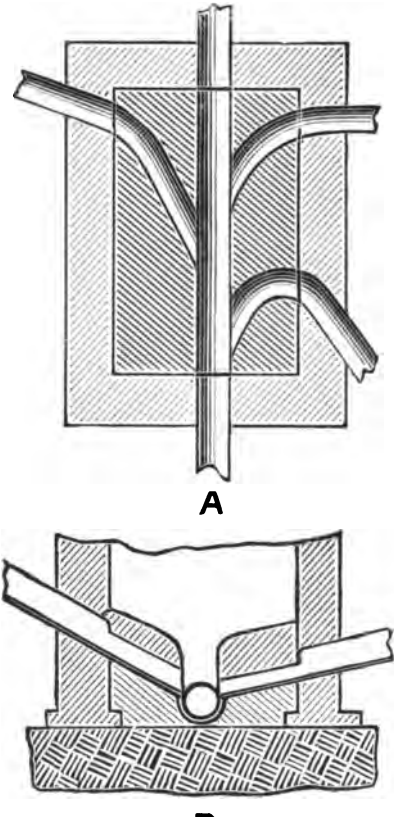


FIG. 73.

manhole. For instance, one very often finds a manhole arranged like Fig. 72A, with the result that every discharge from the soil pipe is carried over the benchings on the opposite side and thus causes an accumulation of filth. If the main channel were made deep enough it would not matter so much,

but in most cases it is no deeper than a half-channel pipe, which in any case is absurd, even if there were no branch channels. It is obvious that the main channel should at least be as deep as the drain in connection with it, whereas in the majority of instances it is like A, Fig. 72, instead of being raised to the depth of the pipe as shown at B. With regard to the channel junctions just referred to, they have several disadvantages when compared with the method of discharging the branch channels over the side of the main channels. One is, that a joint is necessary in the main channel to each junction, as shown at Fig. 71, and as already stated, the angles of the junctions cannot be arranged to suit the various branch drains so readily as those discharging over the side of the main channel, as shown in the plan and section at Fig. 73 or Fig. 74, which represents the plan of the manhole we are principally considering.

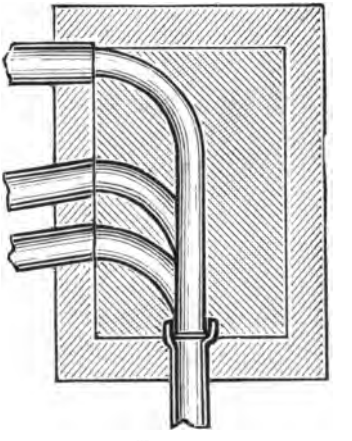


FIG. 74.

In addition to the facilities which this form of channel affords for joining the main channel at a suitable angle, there is often a great advantage in keeping the branch drains above the bottom of the main channel and thus preventing a wash back of solids up a branch drain which is probably very little used, and has not sufficient flushing power through it to keep it clean. The result in many cases is either a stoppage or a large accumulation of solid matter which becomes a nuisance. Another advantage is that the branch channels can be laid to any fall to suit the branch drains, whereas the channel junctions are not so easily adjusted to suitable falls.

CHAPTER XV.

MANHOLES—(*Continued*).

HAVING arranged the channels at the bottom of the manhole in a satisfactory manner the whole of the inside of the brickwork should be rendered with neat cement and trowelled to a smooth face. This is not generally done in small works, where economy is an object; but as there is only one manhole in the system of drainage we are considering, as will be seen by the plan, the extra cost of rendering a manhole about two or at most three feet deep from the benchings is very small indeed. And the advantages of making them non-absorbent is obvious, more especially when the water test is applied to the manhole as well as the drain pipes. The rough and ready method of rendering the manhole with a compo of sand and cement, and merely finishing the surface with a wooden float, is not satisfactory. It is all very well as far as it goes, but it should always be faced up with neat cement, and trowelled so that the surface is quite smooth and is easily cleaned. Some will object, and say that the facing of neat cement will flake off; but this only occurs when it is improperly done; either it is put on too long after the floating is set, or the neat cement is too hot and required cooling before it was used. When it is carefully done it is very durable, as my experience proves during the last quarter of a century. Some would no doubt suggest white glazed bricks for the purpose; but in the present case they are not only unnecessary, but it is doubtful sometimes whether they answer the purpose so well as a smooth cemented surface in

any case; in several instances in my own experience the glazed surface has had to be hacked off, and the manholes cemented as above described in order to render them water-tight. One does not mean to say that a glazed brick manhole cannot be made water-tight, but if exceptional care is not taken in building them they will leak like a riddle. With regard to the cover of the manhole there can be no doubt that an iron air-tight cover of some reliable kind is the best and generally the cheapest method to adopt, whether the cover is level with the surface of the ground, or is placed a few inches below, if the appearance of a manhole cover is objected to. If merely stone slabs are used, the cover is best in two or three pieces; one large stone is a most awkward thing to lift, and is generally a nuisance when the manhole has to be opened. The best plan to adopt, if only stones are used, is to make the cover in two pieces, one part to remain a fixture, and the other made to lift up easily by means of iron rings, the stone being bedded with mortar. This method is shown at Fig. 75 A. When manholes are more than usually large the cover stones can be made in three pieces, as shown at B, the centre opening being just large enough for a man to pass through comfortably.

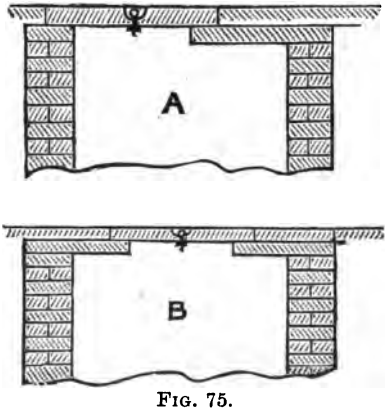


FIG. 75.

A good plan, although more expensive, is to have a large stone with a round hole cut in the centre, and the cover stone made to cover it, like Fig. 76 A, or to fit with a dove-tail joint like B. It is obvious, however, that this joint should not be made with either cement or mortar. Grease

should be the material used, if anything is necessary. In many cases the cover is made to fit the opening so nicely that no cement of any kind is required, especially when the cover is a few inches below the surface of the ground, as it is supposed to be in this case. In my opinion, however, nothing is more suitable than an iron cover, whether it is below or at the surface, because it is easily removed and replaced. The simplest kind of iron manhole cover is that having a flange for setting on the brickwork, as shown at Fig. 77, and if it is too small for the manhole a few sailing courses in the brickwork, as shown in the section, will provide a good bearing for the flange. In some cases where the manhole is very shallow a piece of York stone, bedded over one end, as shown at Fig. 78, is a convenient plan to adopt. A much better plan is to use an iron cover, without a bottom flange, and let it

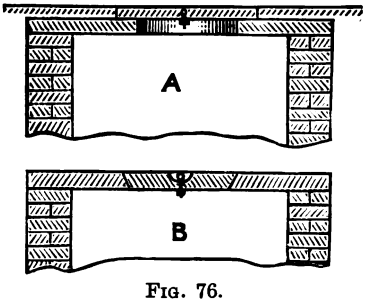


FIG. 76.

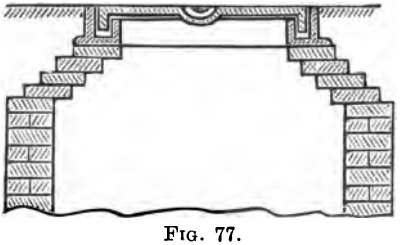


FIG. 77.

into a York stone, large enough to cover the manhole, as Fig. 79, the top of the stone being level with the surface of the ground. This plan is more particularly suitable in a paved yard; but if the surface is cemented, the former cover answers the purpose, because the cement can be made good to the iron frame, although the stone would be neces-

sary if the manhole is large. Great care should be used in bedding the iron or stone cover of the brickwork of the manhole, and the joint inside should be carefully stopped after bedding. Many cases have occurred where the smoke from a drain-testing machine has found its way from a defective joint of this kind under the paving for several feet, and through openings in the wall to the house.

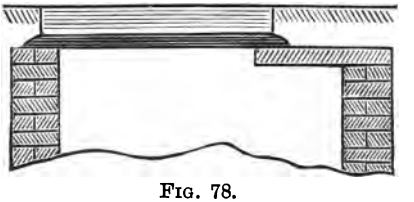


FIG. 78.

On referring to the drain plan it will be seen that an air inlet pipe is shown, connected to the drain near the outside water-closet. Where expense is no object, it would be preferable to ventilate this part of the drain by a special upcast pipe taken above the roof in addition to the soil pipe. Some would consider that as the soil pipe is connected to the drain leading to the manhole close by, ventilation at this point is

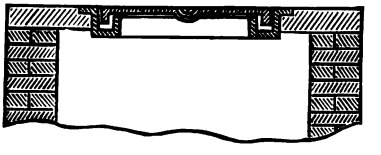


FIG. 79.

unnecessary. But as one of the important rules with regard to modern drainage is that, with the exception of very short branches, the whole of the system should be continually flushed with fresh air, an economical method in this case is suggested. This can be arranged with a short length of galvanised iron pipe connected to the branch drain below the ground, and the upper end fitted with a mica valve of the

kind shown at Fig. 80 A and B; the latter is intended for letting in the face of a wall. One is, of course, well aware of the objection raised to mica inlet valves, of their somewhat temporary character, and the probability of their acting as outlets instead of inlets. But these faults, as will be pointed out as we go on, depend to a very great extent upon the arrangement of other parts of the work. In fact, where the other parts of the sanitary work are carried out in a proper manner the mica valve might be dispensed with, and an open grating at a low level would give no cause for complaint. There is one very important point to consider in connection with the junction between the ventilating pipe and the drain. In many instances it is connected in the same manner as an ordinary junction from a water-closet or gully. That is to say, the junction is laid on its side like that shown at Fig. 81 A, as it should be in those circumstances. But when it is only a ventilating pipe, as in the case under consideration, the discharges from the water-closet would wash back up the branch pipe, and it would ultimately be stopped up by solid matters as indicated in the sketch. This, indeed, was found to be the case in numerous instances. It is obvious therefore that the junction should always be as near to the centre of the top of the pipe as possible in the manner shown at B, so that the discharges cannot under ordinary circumstances be washed up into the branch pipe. Another point to be noticed is that the earthenware socket should always

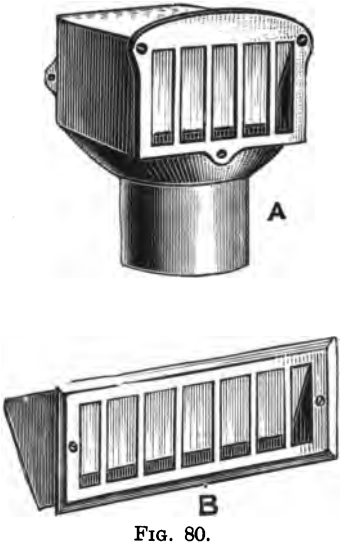


FIG. 80.

be brought up to the level of the ground or paving, as the case might be, so that the joint between the iron and drain pipe is seen. This is important, because not only should the joints between two kinds of material be visible, but if a part of the iron pipe is buried below the ground level, it is likely to be acted upon by the damp earth being in contact with it, and rapid decay is often the result.

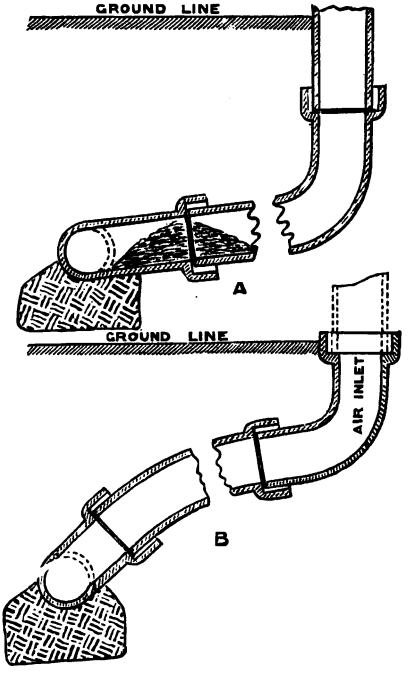


FIG. 81.

CHAPTER XVI.

IRON SOIL PIPES.

THE next thing to consider is the soil pipe. It is generally considered that iron pipe is the most economical, but if it should happen to be under the London County Council's regulations there is a question whether the strength of iron pipe which is required by the sanitary authority is cheaper than lead, more especially if it is necessary to fix a lead branch through the wall to the water-closet and provide gun-metal connections between the lead and iron, and also between the earthenware water-closet and lead pipe.

And as the regulations of the London County Council are being very widely adopted, it may be well at this point to call attention to them. The clause in the *amended* bye-laws referring to soil pipes states "That any person who shall provide a soil pipe in connection with a new building for the purpose of conveying to the sewer any solid or liquid excremental filth, or shall for that purpose construct a soil pipe in connection with any existing building, shall, whenever practicable, cause such soil pipe to be situated outside such building, and shall construct such soil pipe in drawn lead or of heavy cast iron. Provided, that in any case where it shall be necessary to construct such soil pipe within such building, he shall construct such soil pipe in drawn lead and so as to be easily accessible. He shall construct such soil pipe, whether inside or outside the building, so that its weight, if the pipe be of lead, and its thickness and weight

if the pipe be of iron, in proportion to its length and internal diameter, shall be:—

Diameter.	Lead weight per 10 ft. length not less than	Iron.	
		Thickness of metal not less than	Weight per 6 ft. length (including socket and beaded spigot or flanges (the socket not to be less than $\frac{1}{2}$ in. thick)) not less than
In.	Lb.	In.	Lb.
$3\frac{1}{2}$	70	$\frac{5}{16}$	50
4	80	$\frac{3}{8}$	60
5	100	$\frac{1}{2}$	80
6	120	$\frac{1}{2}$	100

These are somewhat heavier than the weights in the first bye-laws, which were as follows:—

$3\frac{1}{2}$	65	48
4	74	54
5	92	69
6	110	84

But if iron is used it is much better to construct the soil pipe entirely of iron, and not introduce a small piece of lead if it can possibly be avoided. With regard to the jointing of the iron pipes, the bye-laws go on to say that—"If he shall construct such soil pipe of cast iron with socket joints, he shall cause such joints to be not less than two and a half inches in depth and to be made with molten lead properly caulked, and he shall also cause the annular space for the lead, in the case of three and a half inch and four-inch pipes, to be not less than quarter of an inch in width, and, in the case of five-inch and six-inch pipes, to be not less than three-eighths of an inch in width".

No mention is made of coating for iron pipes, but no argument is necessary to show the necessity for some means being used to coat both the inside and outside surfaces with some form of preservative solution. The most economical is Dr. Smith's solution, which is of a bituminous nature and

consists of a mixture of pitch, tar and linseed oil, and into which the pipe has to be dipped while it is hot, soon after being removed from the casting mould. The mere painting the solution on afterwards is of little use, as it is not durable and is likely to flake off very quickly.

Ordinary painting of the pipes is better than nothing, but at best it cannot be regarded as satisfactory.

In addition to the solution invented by Dr. Smith, already mentioned, for coating iron, soil and other pipes, there are several other processes employed; some with the object of protecting the surface from oxidation only, and others intended not only to have this effect, but to render the inside of the pipe smooth and free from obstructions. Galvanising, for instance, is one of the best means for preventing oxidation, both inside and out; and when the pipe is a fairly good weight and the joints properly caulked with metallic lead, it makes a good substantial soil pipe.

The disadvantage, however, of the galvanising coating inside is that instead of smoothing over the rough surface of the cast iron, it in most cases makes it worse, so that one cannot always depend on a clean surface to the soil pipe.

Another method of protecting the surface of soil pipes, both inside and out, is by what is known as the Bower Barff process. This treatment does not materially affect the character of the surface of the metal; in fact, excepting that the surface looks much darker than that of ordinary cast iron, one would not suspect that it had been subjected to such a radical process as it has. The process really consists of the conversion of the surface of the metal into a black magnetic oxide by the metal being placed in an oven of superheated steam. This coating has been known to withstand the action of water, dampness and the weather for many years without any signs of rust appearing; but for some reason or other it does not seem to have become popular, at any

rate in this country. One drawback, of course, is that it does not form a finishing coat, nor does it make the surface smooth.

The best inside coating for cast-iron soil pipes and drains is generally acknowledged to be the glass process, which has been greatly improved upon during recent years. This consists of a thoroughly smooth, glassy surface, about one-eighth of an inch thick, and is said to withstand the action of most of the common acids; but as soil pipes as a rule are not used to convey acids, at least in their crude form, such a recommendation carries very little weight.

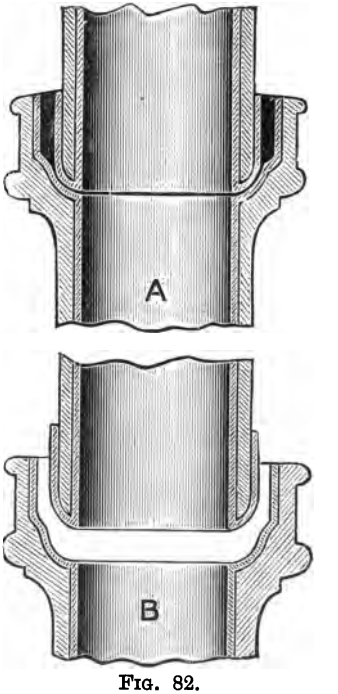


FIG. 82.

The most important feature of glass, or any other lining which is of an entirely different character to the metal it is required to adhere to, is that it should expand and contract with the variation of temperature in the same proportion as the metal to which it is attached, and thus avoid fractures of the surface and ultimate exposure of the surface of the iron, which, when once exposed in the smallest degree, will soon enable the oxide of the metal to form, so that the removal of the rest of the protective coating is then only a matter of time—and that very short, according to some cases in my own experience. We are told, however, that the more recent improvements in the manufacture of this form of soil pipe have overcome most of the difficulties which led to the faults above alluded to, and it is being used some-

what extensively. Great care is necessary when lengths have to be cut, so that the end of the glass lining has a clean edge; but if a fracture should occur, the exposed part of the iron should be well painted with red lead or gold size or something equally substantial. Indeed it is advisable to always apply this solution to the end of a pipe after it has been cut.

The latest style of soil pipe, which is supposed to overcome every objection, is the combination of lead and iron. It consists of an ordinary cast-iron coated pipe having a lead lining inside. The lead lining is in no way attached to the

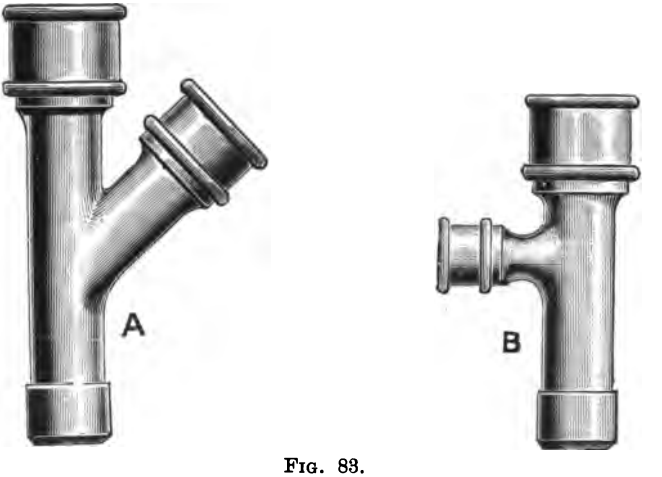


FIG. 83.

iron, but is simply a light lead pipe slipped inside the iron casing and worked tight into the socket at one end, and turned back over the outside of the spigot end to a length equal to the depth of the socket. This outside piece can either be tafted and bossed over, or a separate piece can be fitted on, and the joint to the outside lining made by the burning or fusing process. Fig. 82 A and B are sections of the socket joint, one not down in its position, and the other properly fitted and ready for caulking. The joints are caulked with metallic lead in the usual way by filling up the joint

with molten lead, and tightening it up with a caulking tool. With regard to its durability, in my opinion it has not been in practical use long enough to prove its efficiency. True, it has been subjected by special tests to the effects of extreme heat and extreme cold alternately; so far, it is said, with satisfactory results. But no comparatively short tests under special conditions will give the same results as when a pipe is fixed under ordinary circumstances, and a reasonable time allowed to elapse before the effects, if any, are ascertained.

The principal argument used in favour of lead-lined pipe is the rigidity of the iron casing and the secure fixing which it affords, and the non-corrosive character of the lead lining, which, being secured in an iron casing, is made practically indestructible; whereas lead pipe alone will be made to sagg, bend and break by the variation of temperature. The junctions are lined with lead in the same way; these are the ordinary improved shape of junction as shown at Fig. 83 A and B. It is obvious, therefore, that the lead lining must be placed inside in two pieces. The seam between the main and branch pipes is burned, or fused, by the autogenous process, and any projection above the inside surface cleaned off. As to the seams in the junctions, they may, of course, be all right, but all one can say is, they are certainly open to doubt as to durability. It must be remembered that the effects of expansion and contraction on lead are very gradual, and it is the continual repetition of the application of heat and cold during several years which does the mischief.

CHAPTER XVII.

IRON SOIL PIPES—(*Continued*).

IN the case of a small villa residence of the kind we have been considering, it would probably be decided that the soil pipe should be of cast iron, and of such a strength as to allow of the joints being caulked with metallic lead; and as the soil pipe will also act as drain ventilator, it would be advisable to use a four-inch pipe. The tendency during recent years is to reduce the size of soil pipes as small as possible; and when regarded from a sanitary point of view, so far as the self-cleansing action is concerned, no objection can be raised. And in cases where there are two or more soil pipes in connection with one system of drainage, the pipes can be as small as practicable. But when one soil pipe has to ventilate the drain, it is not reasonable to check the air flush through the drain by small pipe; at any rate it should not be less than four inches, because in most instances where a modern water-closet having a fair water supply is fixed, a four-inch pipe gets well flushed by the discharges, and remains free from corrosion. And while one does not deny that a three or a three and a half inch pipe is flushed better, the advantage gained in this way is much less than that obtained by larger area and less friction for the quicker passage of air. Another disadvantage of small soil pipes has frequently been discovered in cases of this kind. It has been found that when the upper water-closet is used, the discharge so completely forms a kind of plug when passing down the soil pipe that the air in the drain is compressed sufficiently to

cause the water in a gully or the trap of the servants' water-closet to be blown out. In many cases an additional drain-

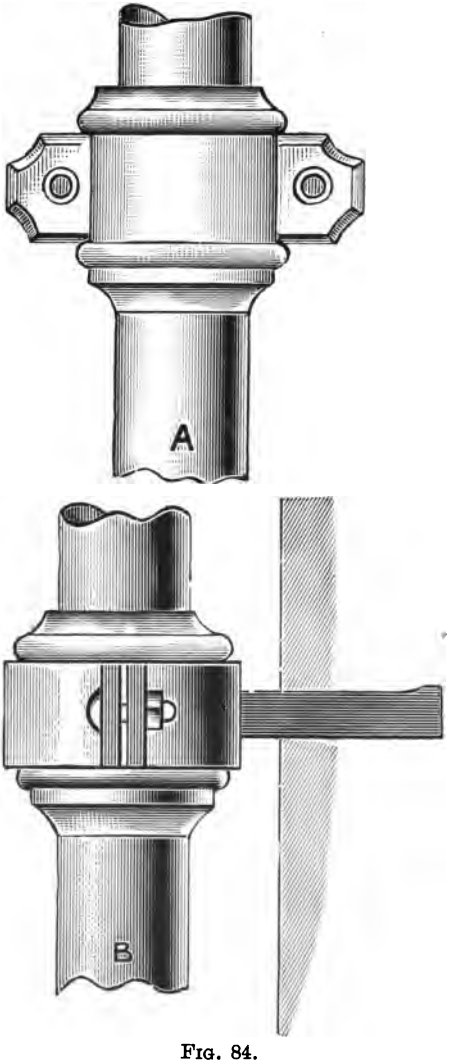


FIG. 84.

ventilating pipe has had to be fixed in order to relieve the pressure produced. This would, of course, not occur when

an open grating is used for the air inlet to the drains; but when a mica valve is used, the lower parts of the soil pipe and drain are hermetically sealed, and no relief is given to the compressed air. In most cases where the soil pipes are not more than forty or fifty feet high, the use of a four-inch pipe instead of a three and a half has made all the difference.

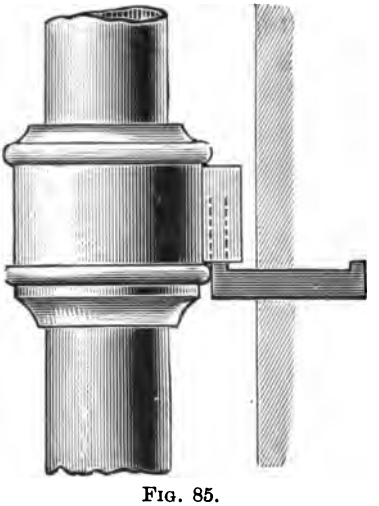


FIG. 85.

Although half an inch in the diameter does not seem much, it makes a good deal of difference in the area. As areas of circles are in the same proportion as the squares of their diameter, it will be found that the difference in the areas of, say, a three, three and a half and a four-inch pipe is the same as nine is to twelve and a quarter and sixteen.

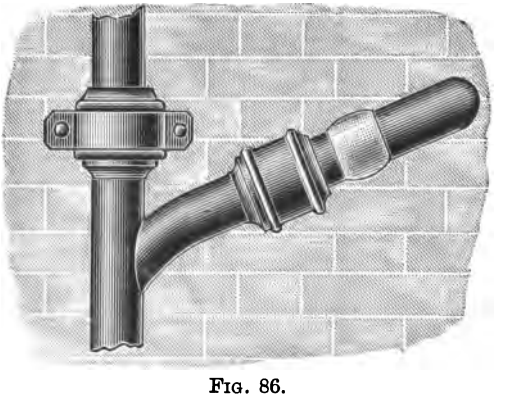


FIG. 86.

The weight of the iron pipe should be from fifty-four lb. to sixty lb. to the six-foot length, and fixed either with

strong ears cast on the sockets, as A, or by means of holderbats pinned into the wall in the manner shown at Fig. 84 B. The latter method is the most convenient, and in many cases preferable. The bends or junctions, for instance, can be used in any suitable position, whereas when ears are cast on the sockets they can only be fixed on one side.

The holderbats are sometimes made of wrought iron, and very often of malleable iron, the front piece being bolted on after the pipe is in its position. In some cases the fixing takes the form of a spur and socket, as shown at Fig. 85; the socket being formed at the back of the pipe, and this is hooked over the spur, which is pinned into the wall. This is, however, open to the same objection as the ears, as the fittings must be fixed on the side they are prepared for. The next point which requires attention is that when soil pipes are formed of iron they should, as far as practicable, be all iron, and not an indiscriminate use of iron and lead mixed up in a patchwork form. If, in the circumstances of the case, it is necessary to use lead pipe for a large part of the work, then it is much the best plan to make it all lead. In the case of a branch from the water-closet, especially where a lead trap is used, a lead branch through the wall is not objectionable, providing the connection to the iron junction is properly made by means of a brass ferrule having a

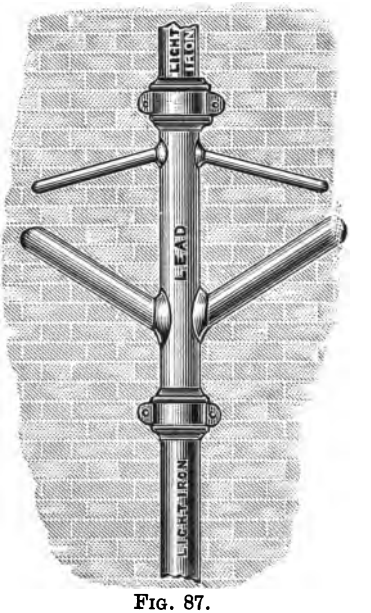


FIG. 87.

soldered joint to the lead pipe, and a caulked lead joint to the iron socket, as shown at Fig. 86. But when one comes across such an arrangement as that shown at Fig. 87 a feeling of disgust cannot be avoided, when an otherwise good job is spoilt for the sake, as it appears, of saving a few shillings, where the extra expense should not have been considered. The lead branches to two water-closets with the two branch ventilating pipes and joints were fairly well and substantially done, but the light iron pipes at the bottom were merely slipped on to the lead and the joint made with white-lead putty. The upper length of iron pipe was socketed to the lead upside down, and the putty joint was falling out. If a length of iron pipe were fixed at the bottom only, there would not have been much objection, but the upper part should surely have been continued in lead.

CHAPTER XVIII.

LEAD SOIL PIPES.

ONE of the principal reasons why iron soil pipes are used so extensively is owing, doubtless, to their cheapness as compared with leaden pipes. It will be found, however, that this only applies to light uncoated iron pipes of rain water pipe strength; for if soil pipes are constructed of strong coated or galvanised pipes, and the joints caulked with metallic lead, the cost will amount to as much as that for lead pipes throughout, and in some cases the lead is the most economical. In the case under consideration, where there is supposed to be only one water-closet on the soil pipe, the difference in cost of the two metals would be so small as to be not worth mentioning.

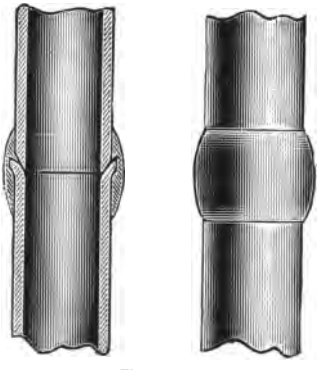


FIG. 88.

If the soil pipe is of lead it should not be less than seven lbs. to the foot, the joints should be properly wiped, and the fixing substantial. This suggests another reason why iron is often fixed instead of lead. There are many plumbers who can manage to wipe a small joint fairly well, but to prepare and fix a lead soil pipe, and make the wiped joints in their position, is quite out of the question. Iron pipes are therefore used to overcome the difficulty. Fig. 88 shows a section and outside view of a wiped soldered

joint,[1] which of course requires a fairly skilful plumber to make it in such a way as to be both substantial and neat in appearance. With regard to the fixing of lead soil pipes, there is only one proper way of soldering the tacks on, but the kind of tack and the number which should be fixed to a ten-foot length of pipe is often the subject of discussion; although little need be said about the advantage of a thick cast-lead tack over the sheet-lead tack which was universally used until about fifteen years ago.

How frequently one finds the sheet-lead tacks torn away

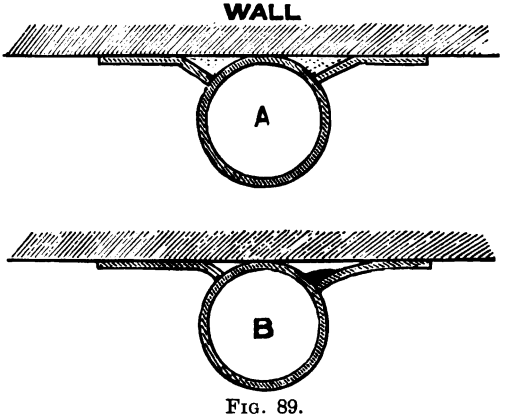


FIG. 89.

from the wall hooks with which they were fixed to the wall! Yet the same amount of lead made up into a cask tack of about three or four times the thickness, and having an ornamental and more substantial appearance, and fixed with galvanised nails, has four times the strength of sheet-lead tacks.

The point, however, is that they should be soldered to the pipe securely in the manner shown at Fig. 89 A, and not, as they often are, like B. Then as to the number to a ten-foot length; for short soil pipes, where the variation of tempera-

[1] See *Hints to Plumbers* for further particulars.

ture is not likely to affect the pipe, three tacks fixed like that shown at Fig. 90 A is sufficient, and really more effective than two pairs of tacks like B, although this plan is generally regarded as having a better appearance than the odd single tacks as those at A.

But so far as strength is concerned, in my opinion the three are better than the two pairs, because in the latter case there is too much strength in one place, and the fixings are five feet from centres. But with the three tacks there is quite as much strength as is required at the three parts of the pipe, and the fixings are closer together, namely, three feet four inches. The four tacks would be much more effective if they were distributed like that shown at C, if the appearance was not objected to, but it would certainly be making the best use of the strength available. Where pairs of tacks are insisted upon for plain soil pipes, the method shown at D is the best. This is arranged with three pairs of tacks, but they need not be so large as those used in threes and fours, and two nails in each tack is ample, whereas those used in threes at any rate should have three nails each. It must, however, be recognised that after all it is not so much on the number of nails used that the effective fixing of a lead pipe depends as upon the proper distribution of the hold which the fixings afford throughout the whole length of the pipe.

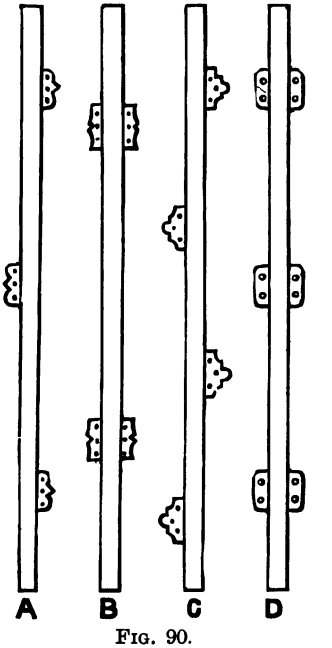


FIG. 90.

In connecting an iron soil pipe to an earthenware drain

no special means are required, for if the pipe is fitted (as shown at Fig. 91) concentric with the socket, and the joint made with Portland cement, the connection can be relied upon. But lead soil pipes are best made good by means of a brass ferrule having a cement joint to the earthenware socket, and a soldered joint to the lead pipe, like that shown at Fig. 92; this is in accordance with the London County Council bye-laws. A good joint can, however, be made without the brass socket, by soldering a lead flange by means of a wiped

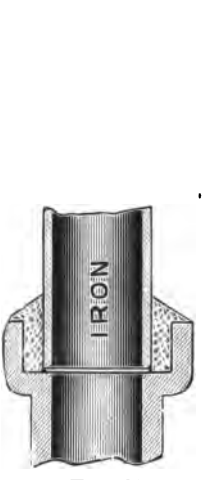


FIG. 91.

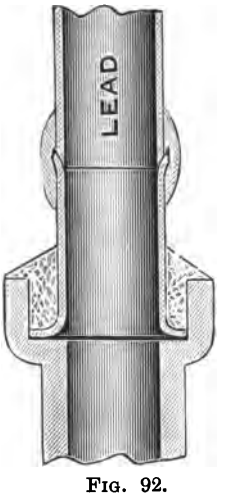


FIG. 92.

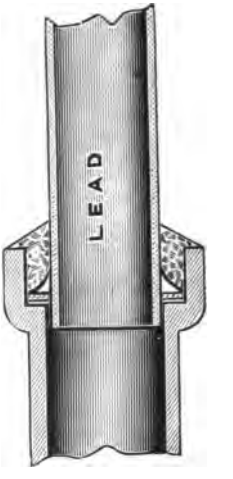


FIG. 93.

joint to the pipe, and carefully fitting it to the socket; the joint can then be made with Portland cement, as shown at Fig. 93. The common method of simply putting the straight end of the lead pipe in the socket is generally regarded as unreliable, and a slovenly job at its best.

It is generally stated that all soil and ventilating pipes should be carried upward in a straight line, and all bends and horizontal parts avoided where it is possible to do so. It is, however, not only impossible in numerous instances to avoid bends, but in many cases there is a decided advantage in

forming bends on ventilating pipes. This may seem a strange statement to make, and will no doubt be regarded by many people as erroneous, especially those who have an idea that all bends, of whatever shape or radius, offer an enormous amount of obstruction to the passage of air through them. Sharp angle bends should of course be condemned, but if the radius is as large as possible, and the parts of the soil or ventilating pipe which have to pass across a wall from one vertical line to another, like that shown at Fig. 94, are arranged similar to A and not like B, there is really no valid objection to them.

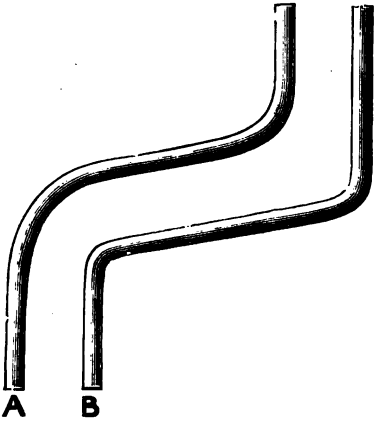


FIG. 94.

The sketch B reminds me of an incident in connection with the sanitary survey of a house, where a sanitary surveyor who had made a report on the same house a few days previously stated that the soil pipe, which in part of its length was arranged similar to the sketch B, was, so far as ventilation was concerned, virtually stopped up; and as there were three other bends besides it must have been doubly stopped up. It would have been interesting to know how the surveyor explained the fact that on the smoke being applied to the drains in the front of the house, notwithstanding that another soil pipe with an open end at a lower level was connected to the same drainage system, the smoke passed through about seventy feet of drain and up the soil pipe of about eighty feet, with five bends in its length, in a few minutes and escaped freely from the top. There are doubtless several reasons why it should pass up the

longest pipe and not the shortest, but in any case it was sufficiently proved that easy bends offer little, if any, obstruction to the upward flow of air at the comparatively slow rate with which it passes up a soil pipe. Another very remarkable case occurred in my own experience. There was a special drain-ventilating pipe and a soil pipe connected to one drain similar

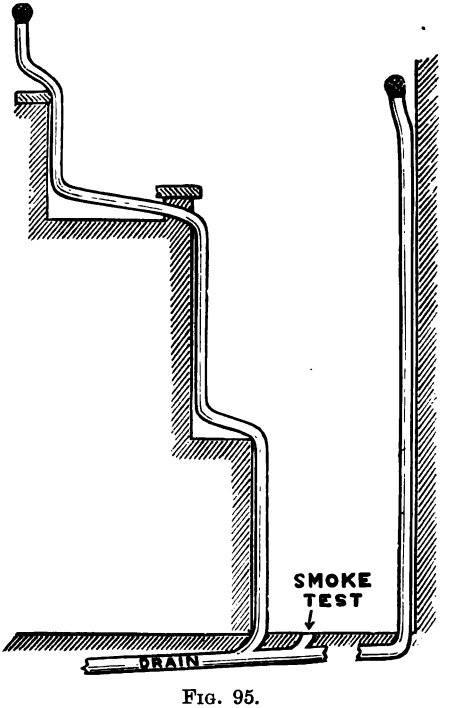


FIG. 95.

to the sketch at Fig. 95. They were both four-inch pipes; the drain-ventilating pipe being nearly straight terminated against a chimney about thirty feet from the ground. The soil pipe was taken up to a higher part of the building, and had six bends in its length; two of the bends were not of the kind that could be called easy.

Now on applying smoke to the drain it was seen in a few

minutes that the draught was up the soil pipe with the six bends, and no smoke escaped from the straight pipe, nor did it for an hour or more. But as soon as the top of the soil pipe was stopped up smoke escaped from the drain vent pipe, and when the stopper was removed the smoke ceased from the straight pipe and passed freely through the soil pipe. One does not wish to prove in this particular case that the bends were an advantage; it was clear proof, however, that they were no disadvantage, even if it is admitted that a certain amount of friction was produced by them. It has been authoritatively stated that in bends which have a radius

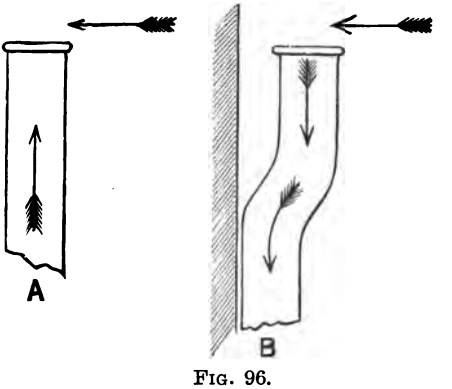


FIG. 96.

of more than five times the diameter of the pipe upon which they are formed, the resistance due to friction need not be taken into account. And where they are in connection with long lengths of pipe the resistance due to a turn in the direction is of still less importance. So that in this case "theory seems to square with practice".

There is another view of the subject which it may be well to call attention to, and where in my opinion it can be shown that bends in a ventilating pipe have a decided advantage, and which the case of Fig. 95 goes to prove. In a previous chapter it was stated that the efficiency of an open grating as an air

inlet to a drain depended upon the arrangement of the ventilating pipe. It undoubtedly does so in many cases where a down draught is complained of—if, for instance, a ventilating pipe terminates in an improper position, where a down blow is produced, at too low a level, or against a flank wall or chimney, or between two pitched roofs. In the case of Fig. 95 the drain vent pipe terminated by the side of a chimney, whereas the soil pipe was above the upper roof and had a clear blow across it.

That a straight blow across the top of a square-ended pipe like Fig. 96 A will produce an up draught is well known, and it is also recognised that if there is anything in the way to deflect the wind current similar to B a down draught will be produced. This can easily be proved in ordinary practice, or as an experiment by means of a piece of glass or other tube with a light ball of cotton wool at the lower end. The tube, which should be about twenty inches long, should be held upright, the lower end being about half an inch from the table on which the ball of cotton wool is placed. On blowing horizontally across the top it will be found that a current of air is induced in an upward direction and the wool is blown up to the top of the tube. If the current of air is blowing from a point below the top of the tube in an upward direction the same effect is produced. But if it is blown from a point above the tube in a downward direction a down draught is produced. A similar effect will be observed when a flat surface is placed behind the open end, thus reproducing the conditions shown at Fig. 96 B.

CHAPTER XIX.

VENTILATING PIPES.

WITH regard to the question as to whether a ventilating pipe should be absolutely straight or bent, it depends, as already shown, on circumstances. It is often remarked that a crooked chimney draws better than a straight one. It will be found, however, that the bends in a chimney or the ventilator of a soil pipe do not necessarily induce a better up draught, but their advantage depends on the fact that bends resist to a large extent a down draught.

When it is realised that resistance due to friction in a pipe increases as the square of the velocity of the air passing through it, the matter admits of a simple explanation. The passage of warm air up a flue, for instance, owing to its steady and comparatively slow upward motion, meets with little if any resistance in the bends in the flue; there is therefore no apparent disadvantage. But if the top of the chimney happens to be in such a position as to induce a down draught by a deflected wind current, this being of a much greater velocity, perhaps ten times more than the up draught, the bends at once resist the down draught by friction caused by the greater velocity. Hence the value of certain forms of cowls which, in the case of a very quick upward current of air, would act as obstructors and cause the chimney to smoke. To a slow up draught they offer very little obstruction, but are more effective in preventing a down draught.

As a rule, short straight flues are far more troublesome than long ones, for a very similar reason. The longer the

flue, the greater is the resistance due to friction, which is not apparent with a slow draught, but as soon as a down blow takes place, the greater velocity meets with more frictional resistance, and thus overcomes, or checks, the down draught.

For exactly the same reasons a soil pipe which terminates in a bad position would be better with two or more easy bends in it. If, for instance, a soil pipe vent is taken through the eaves of a roof like Fig. 97 A, it would be found

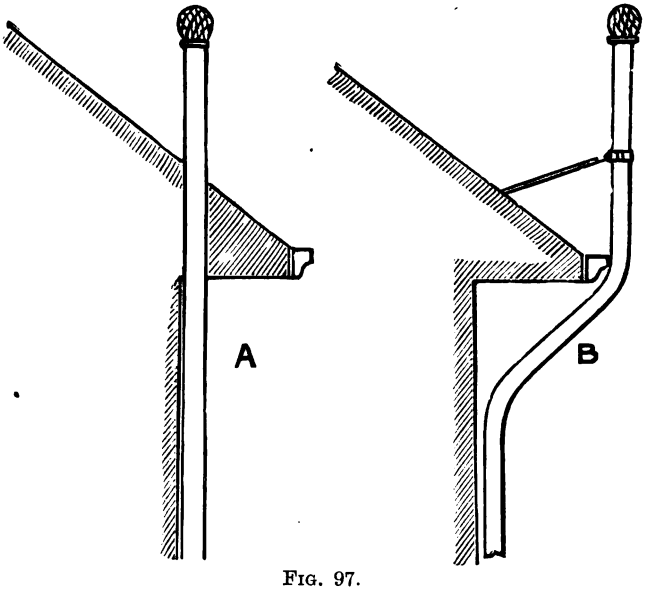


FIG. 97.

to be more effective if it were taken over the eaves gutter with two bends like B. Not that it is desirable to do it in this way, for at best it is a very ugly, and in most cases not at all a satisfactory job; but of the two methods it will be found to give a more constant up draught than the straight one shown at A. One is well aware that this is contrary to the general idea of ventilating pipes, and that it will be regarded by some people as absurd, but when experience and

reason are brought to bear it will be found to be correct. But the best plan is to utilise the two bends in the manner shown at Fig. 98, and take the ventilating pipe to the highest point of the roof. Not that any advantage is claimed for the bends in this case, any more than that they are necessary in order to get the pipe in the most convenient manner to the top of

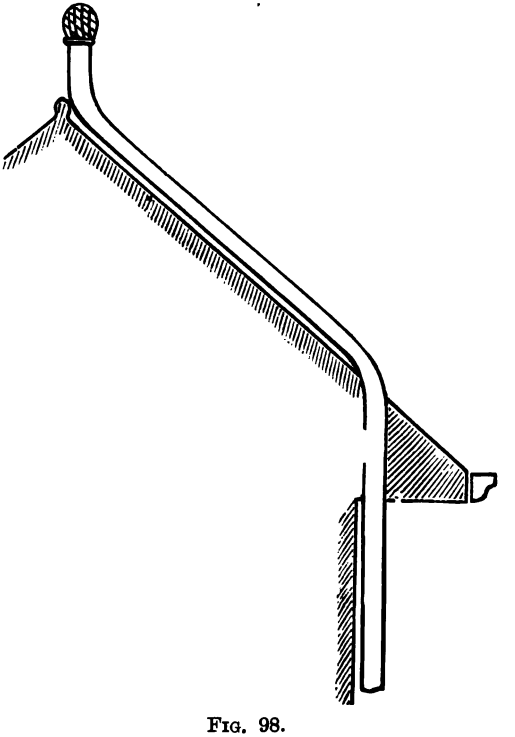


FIG. 98.

the roof. The main point is the clear blow across the top, the effect of which no cowl ever made will improve upon so far as soil pipes are concerned, although there is something to be said for a cowl under some conditions.

It is often very amusing to hear the opinions of some local sanitary authorities on this subject. The bye-laws

sometimes state that the ventilating pipe shall be taken above the roof without bends or diminution in diameter. Of course the inexperienced inspectors have an idea that this bye-law must be carried out to the letter, with the result that many cases have occurred where the method shown at Fig. 98 has had to be altered to Fig. 97 A, which not only brought the end of the pipe nearer bedroom windows, but placed it in such a position as to cause a down draught in three out of four quarters of the compass, resulting in the foul air continually escaping at the air inlet to the drains close to the dining-room windows. Whereas if the pipe had remained where it was first fixed, it would have been satisfactory in every way.

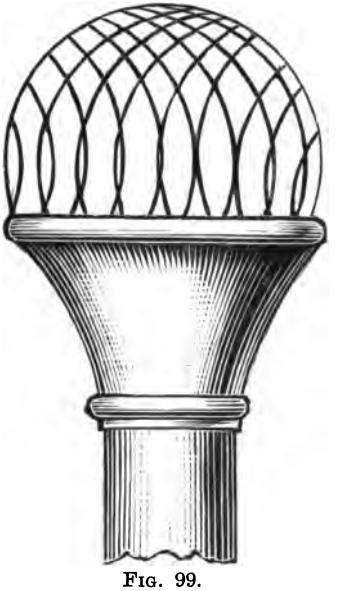


FIG. 99.

A great improvement to the terminal of a ventilating pipe is to open the end in the form of a funnel like Fig. 99, and fix a wire grating of the same size. A bead should be turned on the end, and an astragal soldered on the neck about six inches down; this forms a good finish in the absence of a more elaborate terminal, many of which do far more harm than good. The enlarging of the end is undoubtedly an advantage, because if the wind in blowing over the top produces an up draught, it must be owing to the friction of the horizontal current of air on the air in the pipe, which is induced to follow in the same direction, and thus causes a rarefaction of the air in the upper end of the pipe. The atmospheric pressure, acting through the air inlet below, then flows upwards in order to make up for the partial

vacuum which the cross current sets up. So that the larger the area acted upon by the cross current the greater the power to produce an up draught in the soil pipe.

While on the subject of ventilating pipes it may be well to say a word or two about the advantage or otherwise of cowls being fixed on soil-pipe ventilators. From ten to twenty years ago no soil pipe was considered satisfactory if an exhaust cowl were not fixed at its upper end; and for this purpose the number of different forms of cowls patented, both fixed and revolving, was for a time quite bewildering. But although cowls of some simple form may be used with advantage under certain circumstances, they seem to have dropped out of use almost completely. This is no doubt accounted for by the fact that in the majority of cases no advantage was apparent; and as the result of experiments by various authorities, it was found that an open end, where the wind currents were unobstructed, gave results as good as, and in some cases better than those from cowls of any sort. It is, nevertheless, certain that where the upper ends of ventilating pipes cannot be placed in a suitable position, where down draughts can be for the most part obviated, a cowl or cap can be made to serve a useful purpose by checking the down blow. Mechanical revolving cowls are effective while they remain in good working order; but as they are generally out of reach, and cannot be attended to without considerable inconvenience, they become stationary or otherwise out of gear, and then do in most cases more harm than good; for this reason they have become obsolete, so that where a cowl is necessary it should be of the non-mechanical fixed kind which requires no attention. One of the simplest in form is that shown at Fig. 100. It is merely a conical cap placed about three inches above the end of the pipe, the latter being enlarged similar to that shown at Fig. 99, or the sides opened parallel about six

inches down in the manner shown at Fig. 100, although a very effective result is obtained by a cap over the end without an enlargement, as Fig. 101. By experiment it will be found very difficult, if not impossible, to cause a down blow through a cowl of this kind. If, for instance, the blow is in the direction of either A, B, or C, an up draught is produced, so that if it is necessary for the end of the pipe to

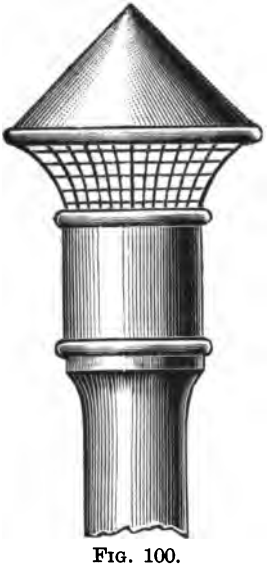


FIG. 100.

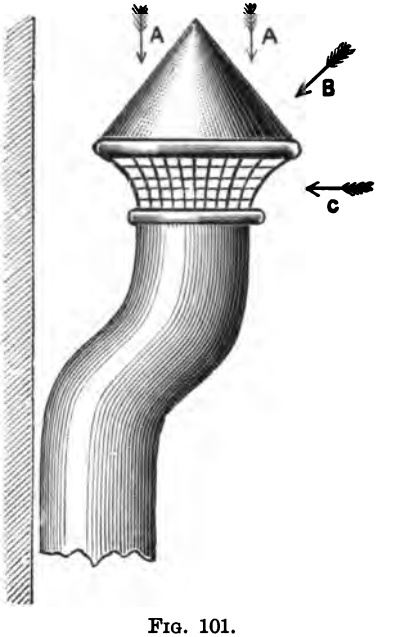


FIG. 101.

terminate at a low level or against a wall or chimney, the cowl cap would be an advantage. In any case, however, the pipe should be made to stand away from the wall as far as practicable by means of a set off, as shown.

Another very simple arrangement, which is far more effective in checking a down blow than is generally supposed, is the tee end as shown at Fig. 102. Where this is used the pipe may be fixed quite close to the wall, but it is

important that one end of the tee should be flush, or project a little beyond the angle of the chimney, as shown in the sketch. This enables the wind to have a clear blow over one end when it is blowing at a right angle to the end of the tee, and has a similar effect to that of blowing over the straight end of a pipe; but a still better effect is produced when the wind blows straight through the tee, more especially when the ends of the tee are made with wide mouths like that shown at Fig. 103. There are but few forms of terminals which will give better results as an air extractor than this when the wind happens to blow in the

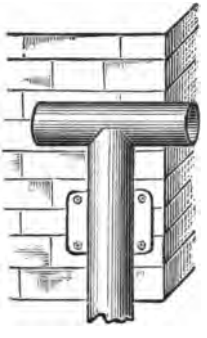


FIG. 102.

FIG. 103.

right direction, although from any quarter the wind will act upon a tee end satisfactorily.

In all cases it is necessary that all the ends or openings should be covered by wire guards, in order to prevent birds from building nests in the pipes. It is remarkable sometimes how it is possible for birds to fix nests in pipes of this kind, and in many instances the amount of material which is carried by the birds is almost incredible. On one occasion, when applying the smoke test to the drains and soil pipe of a country house, the writer could not understand why smoke did not issue from the soil pipe, and on removing the cowl

from the top of the pipe found a nest with four eggs in it, this being supported by the pipe being packed fairly solid with various nest materials for three feet of its length. The lower end of the mass was prevented from slipping down by a bend against the ridge of the roof. In the case of the cowl cap the space beneath the cap should be fitted with a wire guard, as shown at Fig. 100, and the tee should be covered with a flat circular grating. A balloon-shaped grating would not be suitable in this case, because in winter time it is likely to accumulate snow, which for a time may stop it up. This is also the reason why flat horizontal gratings would not be suitable for straight open ends. Balloon gratings will, of course, become covered with snow to a certain extent, but when in an upright position they very rarely become completely covered over.

CHAPTER XX.

WATER-CLOSETS.

HAVING determined the arrangement of the soil pipe, the next in order is the form of water-closet apparatus. This is doubtless the most important sanitary fitting in a house, and on it depends to a very large extent the cleanliness of the soil pipe and drains in connection.

The first thing to consider, however, is the apartment in which the apparatus is fixed. On this also depends the kind of fitting that should be used, because the fitting that would be suitable in a water-closet apartment well removed from bedrooms, and against an external wall, where direct light and ventilation can be easily obtained, would not be so satisfactory in a more confined space, near bedrooms, or in a position where the noise of the great majority of washdown pedestal water-closets would be very objectionable.

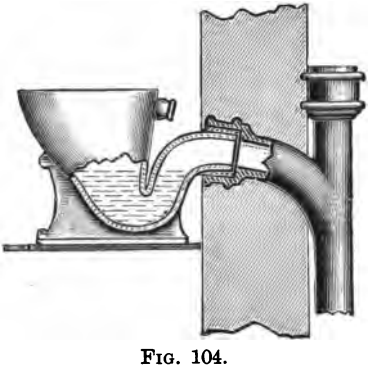


FIG. 104.

It is now generally acknowledged that water-closet apartments should be constructed against external walls, where plenty of light and efficient ventilation can be obtained. But it often happens, when the sanitary arrangements of an old building are being reconstructed, that this provision cannot always be carried out so readily as one would wish, conse-

quently the circumstances should be taken into consideration when the form of water-closet apparatus is decided upon. In the case we have been considering, however, there would probably be no difficulty about the proper position of the upstairs water-closet, so that an ordinary form of closet would answer the purpose very well. And where economy has to be considered, a simple form of pedestal washdown, with a mahogany lifting seat and syphon action flushing cistern would be suitable. A section of such a form of water-closet is shown at Fig. 104. It has a P-trap with an outlet straight out from the back, and is supposed to be connected direct to the socket of a cast-iron junction in the soil pipe, and the joint between the earthenware water-closet and the iron socket should be made with Portland cement. An important feature about these pedestal water-closets is the trap. In many cases the dip or water seal is not sufficient, and the form of the trap is of such a character that it loses its water seal by momentum. That is to say that when a pail of slops is discharged into the water-closet the trap offers such a small amount of resistance to the passage of the discharge through it that the momentum is great enough to carry nearly the whole of the water through the trap and leave no water seal. If the trap is of the form shown at Fig. 105 this action will take place very easily, because the gradient of the outlet is so very slanting instead of being nearly vertical like that shown at Fig. 104. It is very generally supposed that this loss of water seal is caused by syphonage. In fact it has been said that momentum can be prevented by ventilation; but this is a great mistake,

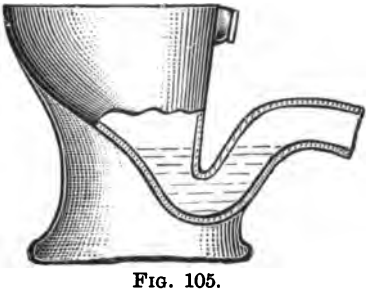


FIG. 105.

the actions of syphonage and momentum being entirely distinct.

This can be easily proved by placing a water-closet on the ground without any soil pipe being attached to it, and pouring a pail of water into it. If the trap is of the proper form, the water seal will be retained, but if not, only about two or three inches depth of water will be left in the trap, clearly showing that, as no syphon is formed by the outlet pipe, syphonage is not the cause of the defect. The same effect is produced by a valve closet on an easy form of round pipe lead trap, about which we shall have something to say later on.

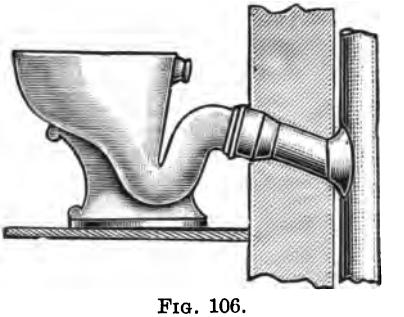


FIG. 106.

When the soil pipe is of lead a closet of this kind should be connected by means of a brass ferrule having a soldered joint to the lead pipe and a Portland cement joint to the earthenware trap, as shown at Fig. 106. This method is in accordance with the bye-laws of the London County Council, and where such a connection is necessary it is one of the best means that can be adopted. Another neater and very generally adopted method of concreting earthenware to lead is the "Metallo-Keramic" joint. By a patented process a metallic surface is burnt on ends of the earthenware traps in such a way as to enable the

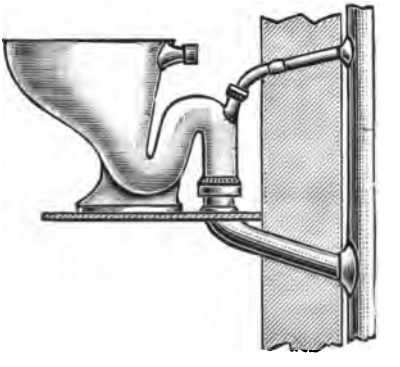


FIG. 107.

lead soil pipe to be soldered either by a copper bit joint in the manner shown at Fig. 107 or by a wiped joint of the ordinary kind. In most cases, however, the manufacturers of the closets make the soldered joint to the earthenware before they leave the works, as there is considerable risk in allowing plumbers who are not used to the work to make the joints. The closets are, therefore, sent out with short pieces of lead pipe soldered to the outlets of the traps and to the ventilation arms, so that the plumber on the job can make good to the soil and ventilating pipes without difficulty.

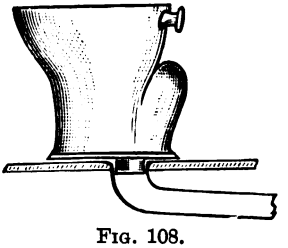


FIG. 108.

When this form of connection was first brought out about ten years ago it was regarded with considerable suspicion, as it had the appearance of being unreliable. But it has so far proved itself to be as substantial as most of the other approved methods of connecting earthenware closets to lead pipes, and it is now being used very extensively. One disadvantage is that, if the closet becomes damaged and has to be renewed, the "keramic" joint cannot be made in its place; it is, therefore, necessary to cut the pipe and make another soldered joint, and, if it happens to be in the wall, some cutting away and making good is required. Whereas with the brass socket and cement joint the latter can be cut out, the new closet inserted, and the joint remade without much disturbance.

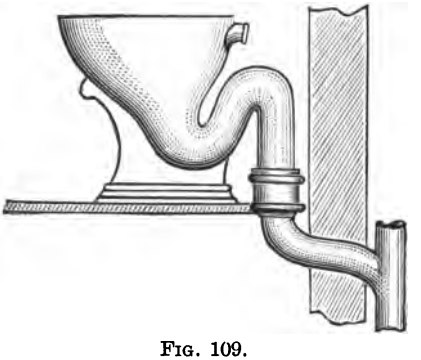


FIG. 109.

One very important feature is that whatever kind of joint

is adopted for connecting the earthenware to the iron or lead pipe, it should always be in sight and easily accessible. The joint can then be examined periodically and any defect remedied without difficulty. On this principle all pedestal water-closets having an outlet at the bottom which is hidden by the base of the pedestal, like that shown at Fig. 108, are now strongly condemned, for not only is it difficult, if not impossible, to make the joint in proper manner, but any fracture that may exist cannot be detected unless a test is applied. And as there always will exist a certain amount of suspicion about a connection between earthenware and brass or iron, as the case may be, owing to the great difference in the character of the materials, periodical examination is really necessary. In more than one case it has been found that a closet being fixed on a wooden floor, and the outlet made good to a socket which is built rigid in the wall, a slight settlement of the floor has caused the earthenware to break or the joint to give way, when weight has been placed on the closet.

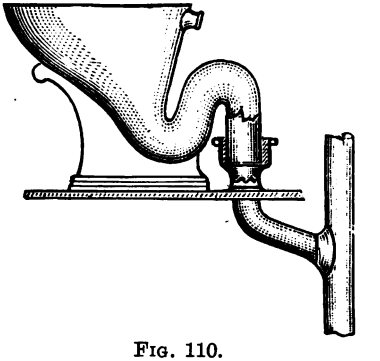


FIG. 110.

This is more especially the case when the outlet is at the back, like those shown at Figs. 104 and 106; but the same thing will occur to a joint on an S-trap outlet, like that shown at Fig. 109, if it is made good to an iron junction with Portland cement. There is some value, therefore, in a joint which is not absolutely rigid, although it may not be in accordance with some modern sanitary regulations.

In the writer's experience some very good and reliable joints have been made between earthenware closets and lead pipes without the aid of brass or iron sockets or Portland

cement. These consisted of sockets formed on the lead branches and filled in with marine glue, a section of which is shown at Fig. 110. The sockets are bossed out and shaped with a mandril, care being taken to get a level shoulder on which the end of the earthenware trap rests. The top edge of the socket has a bead formed in the same material in order to stiffen it. The lower part of the socket should be caulked with tarred yarn to prevent the glue running through to the inside of the pipe, the socket is then filled with glue slightly warmed in a ladle, and then the outside of the socket warmed with a blow lamp. This forms a very reliable joint, which never becomes absolutely hard, and will therefore allow for

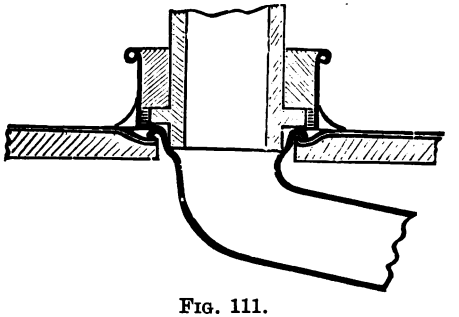


FIG. 111.

contraction and expansion of the metal pipe, and any small settlement that may take place in the floor.

It is very important that the marine glue should not be made too hot, or it is likely to become brittle; the safest plan is to warm it in an ordinary glue pot, which contains water in the outer vessel.

The disadvantage of the marine glue joint is that it cannot be made horizontally, because being necessarily in a semi-fluid state, it must have a perfectly level socket to hold it, otherwise it will gradually run out. One of the best joints of this kind is shown at Fig. 111. This is an old pattern pedestal closet having a flange on the outlet level with the

floor line. The branch soil pipe is tafted into a sinking either in the lead safe or a lead collar made for the purpose, and the earthenware outlet socketed in the ordinary way with a little putty or red lead cement bedding under the flange. A lead socket, having a beaded edge as shown, is soldered to the safe or collar, and is filled as before with marine glue. This, one has no hesitation in saying, is the best joint which can be made between earthenware and a lead soil pipe, notwithstanding the numerous methods which have been employed during recent years.

It is, however, generally accepted among competent authorities that the most satisfactory method of connecting an earthenware closet to a lead or even an iron soil pipe is to form the trap of lead so that a soldered joint can be made to the lead pipe, and thus ensure a reliable connection up to the water seal of the closet. In such a case any injury to the earthenware cannot materially affect the water seal, whereas in the case of an earthenware trap a fracture is often caused by frost, and thus destroys the water seal, rendering the trap useless.

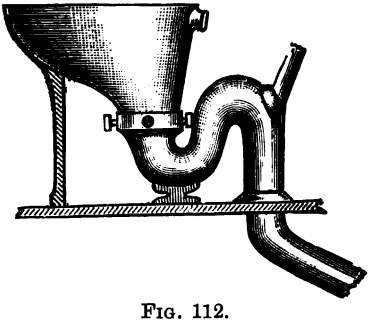


FIG. 112.

A lead trap will, as a rule, resist the action of frost, and remain intact while the basin is broken to pieces. One of the simplest and most effective of lead trap pedestal closets is shown at Fig. 112. It consists of a pedestal and basin in one piece of earthenware, the outlet of the basin being made good to the inlet of the lead trap by means of a brass socket having two or three set screws to keep it in its place, and made water-tight with red lead cement. This joint being on the inlet side of the trap is, of course, comparatively unim-

portant, because the worst that can happen if the joint leaks is the escape of water from the basin. If such a joint were made on the outlet of the trap, it could not be tolerated any more than the old style of red lead joints so prevalent in jerry plumbing.

CHAPTER XXI.

FLUSHING CISTERNS.

THERE is of course much more that could be said about various other forms of water-closet apparatus, but for the purpose of a small villa residence, which has been under consideration, some of those already described would be suitable. A word or two about flushing cisterns would, however, be appropriate at this juncture. Where the water supply is not restricted, there is much to be said in favour of a simple form of flushing apparatus consisting of a lead lined or galvanised iron cistern holding not less than ten gallons of water, and fitted with a round valve, pull and lever similar to that shown at Fig. 113. By this arrangement a small or large flush can be discharged as may be required, and, notwithstanding the water companies' objections to an unlimited supply, such a fitting does not necessarily involve waste of water; for this depends more on the form of closet than anything else. If the closet is of a proper form, and the water flush therefore made the most of, there is no inducement to waste water. Whereas, with the insanitary forms of closet people were induced to use an enormous quantity of

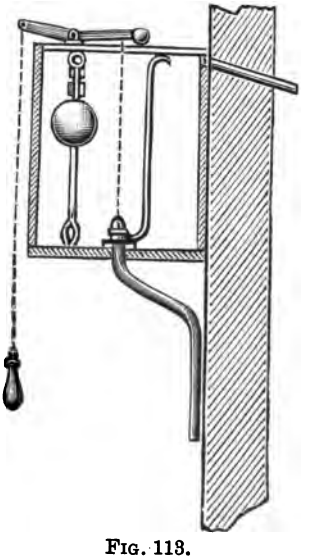


FIG. 113.

water in order to remedy the defects, if possible, of the apparatus.

One of the arguments used against this form of flushing cistern is that careless persons will not hold the pull long enough to give a sufficient flush to the closet. It is not denied that in some cases this is true, but, speaking generally, when a simple apparatus like that shown at Fig. 113 is arranged to give a quick and adequate flush, it with few exceptions gives satisfactory results. And when compared with a very large number of syphon-action cisterns, which are both noisy and erratic and require to be pulled two or three times before the closet basin is properly washed out, the simpler form of flushing cistern is much to be preferred.

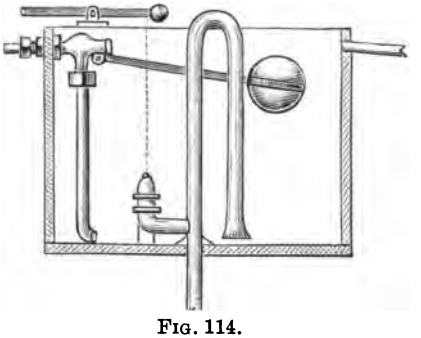


FIG. 114.

However, in most cases, we are not permitted to do as we like, as the water companies' regulations insist on an apparatus which will restrict the discharge to two, two and a half, or three gallons as the case may be, according to the regulations in force in the particular town or district where the closet is fixed.

As to the amount of water that ought to be allowed to each flush; this is a much discussed question upon which experts differ. But, according to the opinions of those who are competent to judge, the two-gallon flush is absurd, and at least three gallons should be the minimum allowance. When a syphon-action cistern is desirable, and the water company is not particular about it being an absolute waste preventer, so called, nothing in my opinion works more smoothly and gives a more certain and satisfactory flush

than a wooden, lead, or copper-lined cistern fitted with a lead, copper, or brass syphon, which is started by a round valve similar to that shown at Fig. 114. One is aware that with an ordinary round leather valve the cistern is not absolutely a waste preventer, because if persons are inclined to fasten the pull down, the water will continue to run as fast as the ball valve will allow it. And if the round valve is not sound the water will waste until the leather is renewed. From the water companies' point of view this is very serious, but, after all, these matters are easily put right and need not give cause for complaint. At any rate the advantages gained more than compensate for the minor weaknesses which, in practice, are found to be of very small moment. An important feature is to render the flushing cistern as quiet as possible, and in this respect the metal-lined wood cistern is the best of its kind. Another important matter is the ball valve; this should be of a kind that will allow of a silence pipe being fixed on the nozzle like Fig. 115 A, and, generally, this form of ball valve is much less noisy of itself than those of the Croydon pattern shown at B. Another advantage which can be claimed for the round-pipe syphon is that a more regular flush is obtained than is possible by most of the valveless cisterns. The advantage of this is generally lost sight of, because many persons suppose that a flushing cistern, which appears to give a rushing and irregular

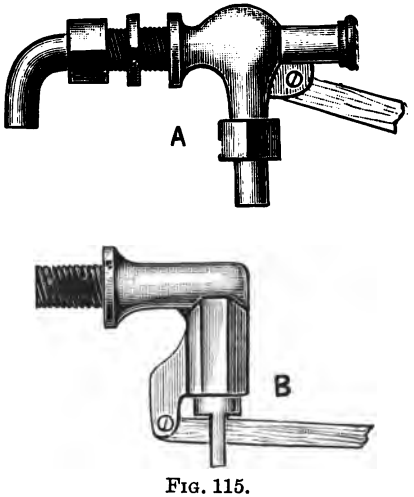


FIG. 115.

discharge, is most effective. This irregularity gives the idea of a great velocity of discharge, but is generally an illusion. The velocity must depend upon the head or height of the cistern in the first place, and this is modified by the form of the syphon or the bends in the flushing pipe. And as there is no form or syphon which offers less resistance to the passage of water through it than an easily bent pipe syphon, it is obvious that what appears in many cases to be an enormous velocity is not what it seems when the whole discharge is taken into account.

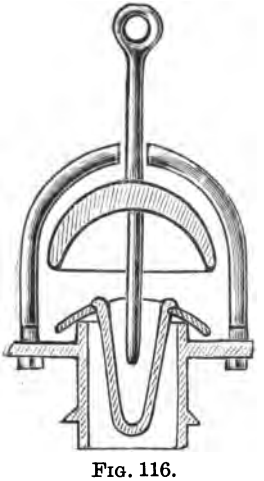


FIG. 116.

As the simple form of flushing cistern already described is not in accordance with most of the water companies' regulations, inasmuch as it is possible to tie down the pull and thus allow the water to run away as fast as the ball valve will supply it to the cistern, other forms of cisterns have to be fixed which render this method of wasting water practically impossible. Where it is required to retain the round-pipe form of syphon, the difficulty is overcome to a large extent by using a waste-preventing valve instead of the ordinary kind of round or spindle valve. This is generally known as the suction valve, a section of which is shown at Fig. 116. It consists of a domical-shaped inverted cup made of heavy metal, such as hardened lead, into which is fitted a rubber valve of a similar shape. When the valve is raised, the metal cup draws up the rubber sealing by suction, as it is called, but really by atmospheric pressure. After a few seconds water passes through a small hole in the metal cup and gets between the metal cup and the rubber, and thus breaks the suction and allows the rubber to fall back to its

seating and so stops the water. But sufficient has been discharged to fill a part of the flushing pipe and set up the syphonic action. Fig. 117 shows the valve fitted to a flushing cistern. These valves are very durable, and will remain in good order for many years.

Although the most particular of the London water companies will approve and put their stamp on cisterns of this kind, there are many provincial companies who will insist upon what is called a valveless waste-preventing cistern. That is to say, the syphonic action must be produced in such a way as to be quite independent of any valve below

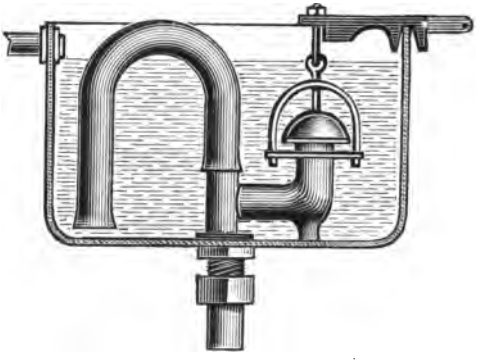


FIG. 117.

the water line, because it is contended that such valves are likely to get out of order, and therefore cause the water to be wasted. The various methods adopted to carry out this idea are so numerous that it would not be reasonable to attempt to describe one tithe of them. But a few typical forms of the most approved kind will no doubt be useful. One of the most important features of a waste-preventing cistern is that the top of the syphon, whatever form it takes, should be above the overflow line, and some companies will insist upon its being above the top of the cistern, as shown in Fig. 118. The object of this is to render it impossible

for the cistern to overflow down the flushing pipe. Many syphon-action cisterns are not made in this way, with the result that, if the ball valve gets out of order, the water will run over the syphon and down the flushing pipe for months without any notice being taken of it. The water companies are therefore very strict on the point, and insist on the overflow pipe being taken through the wall into the open, where it can be seen in the event of water flowing from the cistern.

The cistern shown at Fig. 118 is one of a kind that is now being used very extensively. It will be seen that a round

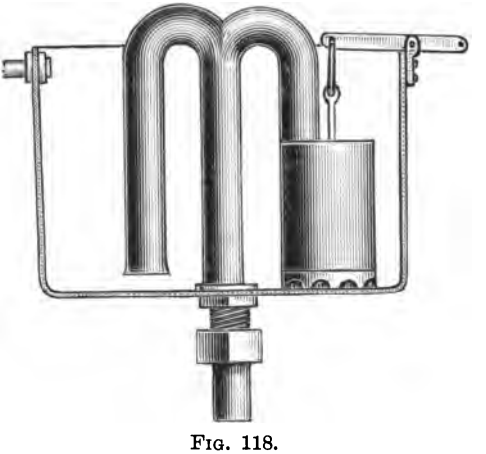


FIG. 118.

pipe bent syphon is used and the syphonic action is set up by means of a cylinder having a loose-fitting piston or disc, which lifts the water up to the top of the syphon, and throws it over into the discharge pipe with sufficient volume to set up the syphonic action. When this form of syphon was first made, the water was drawn by the syphonic action through a loose valve opening through the piston, but this produced a very sluggish flow, which retarded the flushing power of the water. More than one manufacturer has improved upon this by adding another syphon and dispensing

with the valve in the piston. This has the effect of allowing the water to flow through the outer syphon unobstructed, and therefore gives a regular and steady flush to the closet besides reducing the noise considerably.

There is one disadvantage about cisterns of this kind as compared with those which are started by a valve—that is, they must be quite full before the syphonic action can be set up; and where the water supply is very slow, complaints are heard about the difficulty in getting the flush to start. Whereas with a valve syphon, when the cistern is only half full, the syphon will work without difficulty. The valve has also the advantage of being much more sensitive, the slightest pull, whether it is slow or fast, being sufficient to set the syphon going. But the cylinder syphons require a somewhat sharp pull, a slow one being in most cases useless. The difference is one of far more importance than is generally recognised, and often makes the difference between a clean closet and a dirty one. Many persons, after pulling once in an imperfect manner and getting no flush suppose that the apparatus is out of order, and do not persist in setting the syphon in action, the result being a dirty closet and often a choked soil pipe.

CHAPTER XXII.

FLUSHING CISTERNS—(*Continued*).

THERE are three methods in general use for setting up the syphonic action in flushing cisterns, two of which have been already illustrated. The first is by means of a valve which allows the water to flow into the long leg of the syphon, where it produces a partial vacuum in the bend of the syphon, and induces the atmospheric pressure to force the water up the short leg and thus set the syphon in action.

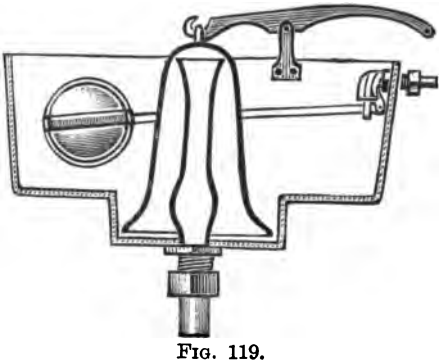


FIG. 119.

The second is to lift the water up and throw it over the bend of the syphon into the long leg quickly enough to fill a greater length than that of the short leg, and so start the syphon. The same, or a very similar action is produced by the annular or bell syphon, which is shown at Fig. 119, but the action is, as a rule, not so certain or effective. By pulling down the lever the bell, or what is really the short leg of the syphon, is raised, and in doing so a part of the water inside is raised with it and thrown over into the open end of the long leg. By this action the water is raised partly by friction and partly by atmospheric pressure, or what is commonly known as suction; because when the bell is raised quickly the air

does not pass up the long leg quick enough to prevent a momentary partial vacuum; and this induces the atmospheric pressure on the surface of the water outside to cause the water inside to rise with the bell and flow over into the discharge pipe.

The third method is illustrated at Fig. 120. By this arrangement the water is forced or driven up and over the bend of the syphon by means of a piston working in a horizontal tube or cylinder, which is a combination of the short leg. The piston consists of a hinged valve which opens

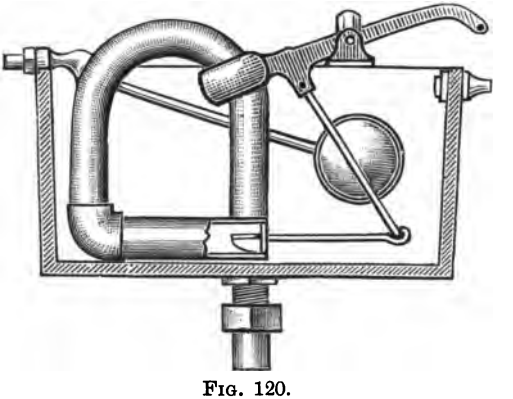


FIG. 120.

inwards and allows the water to pass through freely as soon as the syphonic action is started.

As these cisterns are made of wood and lined with lead, and the syphon is formed of brass tubes, they work very smoothly, and, unlike the iron cisterns, they do not discolour the closet basin with rust stains. A certain amount of loss of power is also avoided in this arrangement by forcing the piston into the bottom of the short leg instead of passing the piston rod through the top of the cylinder as was shown at Fig. 118. The hole through which this passes in most instances allows a portion of the water to be forced through, and also permits air to enter while the syphon is working.

Although this may not be regarded as a serious drawback, it at any rate reduces the effectiveness of the syphonic action in some degree.

As there are bell syphons which are similar in principle to the round pipe bent syphons into which the water is lifted, so there are bell syphons which depend upon the water being forced up, and are therefore analogous to the cistern shown at Fig. 120.

A syphon of this kind is shown at Fig. 121. In the bottom of the cistern a circular well is formed around the discharge pipe. Into this is fitted a large flange which is formed on the bottom of the bell of the syphon. But instead of the bell always remaining down, as is usual with this form of syphon when not in use, in this case it is kept up by a weighted lever.

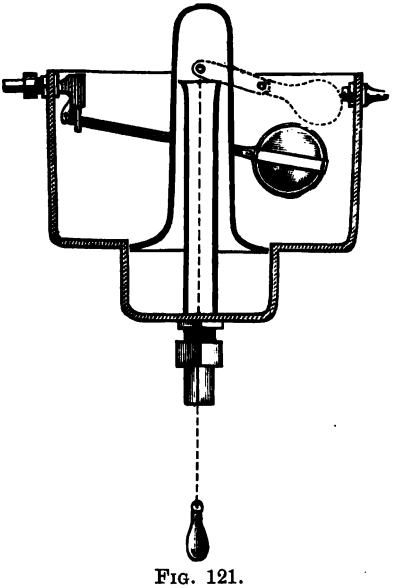


FIG. 121.

When the lever is pulled, the flange on the bottom of the bell descends and displaces the water in the well of the cistern, and thus causes the water to be forced up into the top of the bell and over into the discharge pipe, and sets up the syphonic action. Most of these cisterns are made of cast iron and are somewhat noisy, both in their moving parts and the breaking of the syphon when the contents are discharged; although the noise caused by the latter is modified in this and other kinds of syphons by means of an air valve at the top of the syphon, to which is attached a float, the purpose

of which is to open the air valve when the cistern is nearly empty, and so let the air in at the top of the syphon with less noise than is produced by the air being drawn in at the bottom.

As a matter of fact, a noiseless syphon cistern *per se* is practically impossible; some of course make less noise than others; but my experience has convinced me that the most satisfactory form of cistern, so far as noise is concerned, is one fitted with a simple form of *round pipe bent syphon*, such as those already illustrated, and more especially the cistern made of wood and lined with lead, or copper, the former metal being the less noisy of the two. But if cast or wrought iron cisterns are used they should be enclosed in deal or other wood casings, and packed with non-conducting material. This treatment not only deadens the noise but it protects them from frost, and prevents the condensation of moisture on the surface of the cold iron, and the consequent wetting of the seat.

This of course refers to instances where silence is important and expense is no object, although the cost of enclosing ugly iron cisterns need not be great and the advantages are obvious.

CHAPTER XXIII.

FLUSHING CISTERNS—(*Continued*).

THERE is another class of flushing cisterns which is being used somewhat extensively in houses where for the most part the water companies' regulations are not considered. Many people suppose that if a water company approves of an apparatus, it must therefore be the best and most suitable under any circumstances. But this in most cases is a delusion, for there are many forms of apparatus which for neatness, convenience and efficiency cannot be surpassed, but the water companies, or, at any rate, most of them, will not sanction their use, although the apparatus may be as good a waste preventer as most of those which are sanctioned without question.

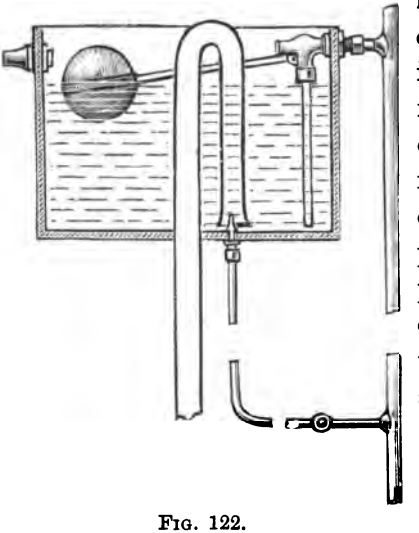


FIG. 122.

The class of fittings referred to is that in which the lever and chain are dispensed with, and the syphon is started by means of a small hydraulic or pneumatic push, which requires but the slightest touch to set up the syphonic action.

These are, undoubtedly, far preferable to the ugly, noisy,

clanking chain and lever which seem to be a necessary accompaniment to the great majority of syphon-action flushing cisterns now in use.

Means can, and of course are adopted in order to make the pull and lever less unsightly and work more smoothly than the more common forms of apparatus, but even then they are clumsy compared with the small and easy working push alluded to.

One of the simplest and most effective forms of syphons which is started by a push valve is shown at Fig. 122. It consists of an ordinary bent-pipe syphon either of copper, brass, or lead, with a jet fixed through the bottom of the cistern, immediately under the mouth of the short leg of the syphon. This jet is fed with water from the same service pipe which supplies the cistern, and is fitted with a small spring push valve.

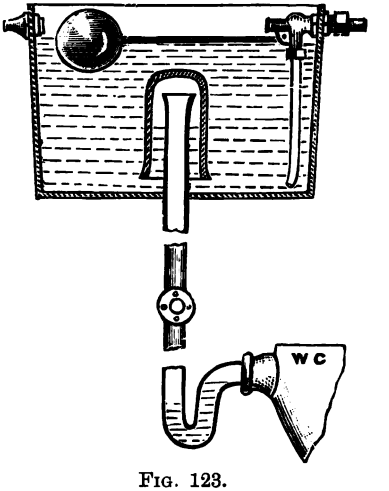


FIG. 123.

When the valve is pushed a jet of water is ejected into the mouth of the syphon, and causes the water to be forced over into the long leg and thus sets up the syphonic action. It is understood that the main objection which some of the companies have to them is the push valve, as it is liable to get out of order and cause waste of water, although it should be pointed out that any water leaking through the valve must pass into the flushing cistern, from which it must overflow through the proper overflow pipe, as it would do in the case of the ball valve leaking. There is, therefore, no reason why this valve should not be

used any more than a ball valve. From my point of view the most serious objection is the possibility of the water in the flushing cistern flowing back into the main pipe when the push valve is not sound and the main supply is shut off temporarily. But if flushing cisterns are supplied, as they should be, from a storage cistern at a higher level such an objection is obviated.

Among the several other methods of starting the syphon by means of a push, the pneumatic arrangements are most objected to by the water companies. The reason is that in most cases of this kind the top of the syphon does not reach above the water line in the cistern. One of the earliest patented pneumatic discharge syphons was constructed similar to that shown at Fig. 123, and most of those in use are modifications of this arrangement. In this case the syphon is annular in form, although it may be made as effective by means of a bent pipe syphon as shown in the next sketch. It will be noticed that the bell or outer tube of the syphon is considerably below the water level, and in order to prevent the water flowing over the inner tube it is necessary to provide some means to imprison the air in a similar manner to that adopted in automatic syphons. This is done by fixing a deep seal trap in the flushing pipe just below the closet seat, so that the space between the water seal of the trap and the level of the water inside the syphon is quite air-tight. The result, of course, is that the resistance of the imprisoned air causes the water to rise above the

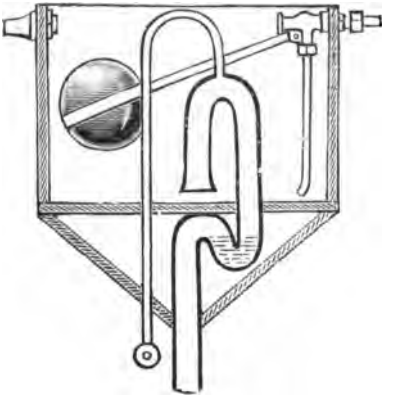


FIG. 124.

top of the syphon as shown in the sketch, the water levels in the trap and the syphon being depressed in proportion to the pressure produced by the height of water in the cistern. A small air valve is inserted in the flushing pipe at a convenient height above the seat; this, when pushed, releases the air, and thus allows the water in the cistern to rush over the inner tube of the syphon and set up the syphonic action. The sketch at Fig. 124 shows a modification of the same principle, but in this case a round pipe syphon is used, and the trap is formed in a box under the cistern, and the imprisoned air is released by a small tube from the top of the syphon and connected to a small push valve similar to that above mentioned.

CHAPTER XXIV.

BATHS.

HAVING described some simple and inexpensive form of water-closet apparatus and flushing cisterns, suitable for a small villa residence either for town or country, the next fitting which requires attention is the bath. This is a fitting which of late years is being regarded as indispensable even in houses with a rental as low as £20 a year. And there can be no doubt that if all dwelling houses, however humble they may be, were provided with a fixed bath of some kind, habits of cleanliness would be still further increased, and every one would enjoy the health and comfort which is derived from frequent bathing. It is remarkable, however, to note, as one is continually doing, the large number of mansions both in town and country which are still without the luxury of a fixed bath, having an efficient supply of hot and cold water. And it is also remarkable, in numerous instances where they do exist, how inefficient and insanitary are the whole of the arrangements. Some of the defects have already been pointed out, so that what has to be done now is to show how these fittings should be arranged satisfactorily. With regard to the material of which a bath should be made, opinions differ considerably, but it depends very much upon circumstances, and cost has a good deal to do with the choice. From an economical point of view the cast iron bath no doubt stands first, for although one of tinned sheet iron, enamelled, or a zinc bath may be suggested, the durability of either of the latter cannot be compared to

the former. Not only does this refer to the metal of which it is made, but the japanning or enamelling does not stand nearly so well on the thin sheet iron or zinc as it does on the more rigid cast iron. The advantage claimed for the thin sheet metal is that it does not take so long to become the same temperature as the water when warm baths are wanted. Whereas cast iron, which is necessarily several times thicker than sheet metal, as are other more substantial baths, takes some time to get warm, and therefore strikes cold to the bather who comes in contact with it.

In this respect, sheet metal, and particularly copper

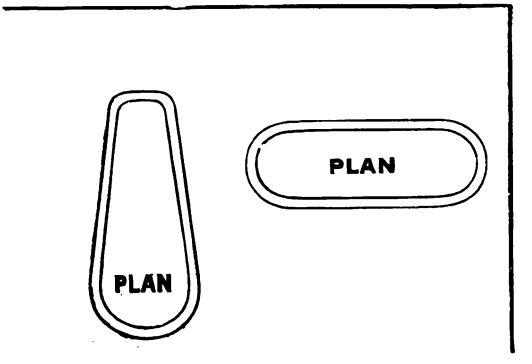


FIG. 125.

baths, are undoubtedly the most comfortable, and where sheet metal is preferred, copper is the best metal for the purpose; but as this is very expensive, and is only used in the best class of work, we must leave any further remarks until another time.

During recent years cast iron baths coated with porcelain enamel are being used very extensively. This enamel when it is properly applied is very durable, and although it is rather more expensive than the metallic enamels, it is far the most economical in the long run. A cheaper enamel of a similar character is known as vitreous, but it is not so re-

liable as the porcelain. These enamels can however only be used on cast-iron baths, those made of sheet metal are not substantial enough for the purpose. So that whatever advantages may be claimed for copper baths it is impossible to enamel them with porcelain or vitreous composition.

The next question is whether the bath shall be provided with an enclosure or shall be made with a rolled edge and stand independent. There are many people, who profess to be authorities on the subject, who will not give this a moment's thought, and will not hear of an enclosure of any kind, under any circumstances. The idea of course is that enclosures encourage the accumulation of dust and filth, but

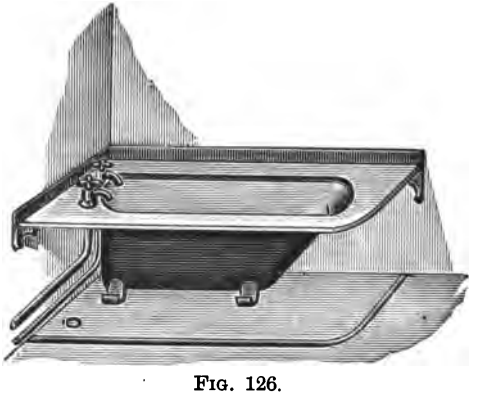


FIG. 126.

an open bath can be kept clean both inside and out without difficulty. This may be so if a bath can be fixed in the middle of a room or one end against the wall like Fig. 125; but as this is generally impracticable, it has to be fixed in one corner with one side against the wall, with the result, in most cases, that the wall and floor behind the bath become begrimed with soapy matters, pieces of soap and other things lie on the floor, and the space soon causes a nuisance, owing to the difficulty of access or cleansing purposes. But with a properly arranged bath, and a well-

fitted enclosure, this objectionable feature is overcome. Most people acknowledge that an enclosed bath is the most comfortable, and excepting in the more expensive fittings and surroundings the enclosure has the most comfortable appearance.

But where cost is a consideration the open bath is of course the less expensive, because the extra cost of a rolled edge over a flat edge is trifling compared with the cost of an enclosure, especially if it is made of mahogany or walnut. One inexpensive method of combining the comfort of a wooden top with the open bath, and at the same time

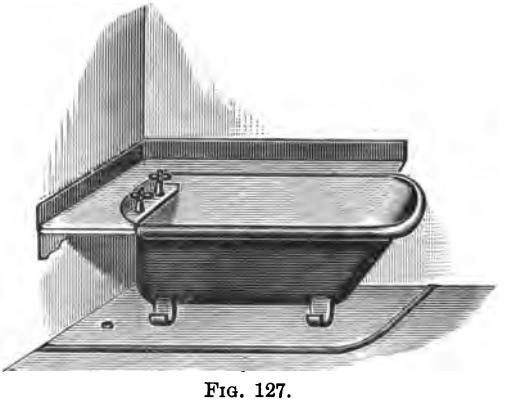


FIG. 127.

preventing the wall from becoming foul at the back and end, and also preventing pieces of soap falling behind, is shown at Fig. 126. It consists of an ordinary flat edge bath with a wooden rim, the back and end made to fit the wall and also fitted with a skirting. Another plan is to fix a rail to the back and end only, using a rolled edge bath as shown at Fig. 127. The supply valves can either be fixed to the wooden rail at the end as shown, or the bath can be fitted with a china slab to which the valves are fixed inside at the foot; no perforations would therefore be necessary in the wooden rail. In cases where the space

is very small, and the end of the bath has to be fixed close to the wall, there may be only room for a wooden fillet, and then bib valves have to be fixed to the wall as shown in the section of Fig. 128.

When the form and arrangement of the bath is determined, the next matter of importance is the waste discharge apparatus; and this, like all other sanitary fittings, should be arranged in such a way as to make the parts that are likely to become foul easily accessible for cleaning purposes. That this is not so in the majority of cases, it is not difficult to show.

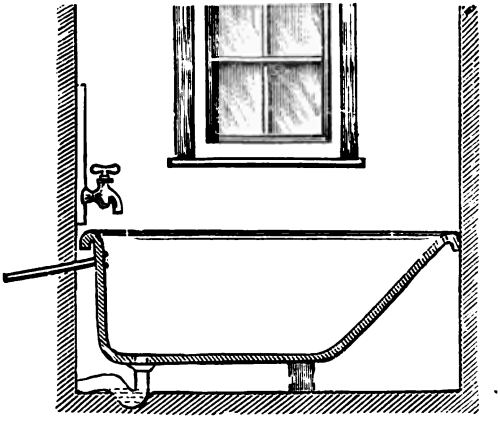


FIG. 128.

Another very important point is that there should be no direct connection between the waste discharge and the water supply to the bath. Not only should the old style of combined waste and supply, connecting with the bottom of the bath, be condemned, but it should not be possible for the water in the bath to find its way into the general service pipes, although this is possible by some of the most modern forms of apparatus, as will be shown presently.

As a matter of fact the most simple and at the same time the cheapest waste and supply fittings can be made the most

sanitary, although they may not be so elegant and convenient as some of the more expensive apparatus. If, for instance, an inexpensive bath is required, the waste may be a rubber plug and brass washer, and a pair of neat bit valves for hot and cold supply, as shown at Fig. 129. The overflow can either be taken direct through the external wall, as Fig. 128, and fitted with a copper flap to prevent a draught through the pipe, or it can be branched into the waste pipe on the bath side of the trap, as shown, by means of a union connection, so that it can be removed for cleaning when required. It is always advisable that the bath should discharge quickly; the plug should, therefore, not be less than one and a half inch diameter, and two inches or more would be better. In all cases the waste pipe should be fitted with a good trap, as close to the bath as possible. The idea that, if the waste discharges into a gully or open head on the external wall, no trap is necessary, is decidedly wrong. No dirty waste pipe of any kind should be allowed to act as a passage for a draught of air into an apartment, or, indeed, inside the house at all, more especially if the waste discharges into a large rain-water pipe which becomes foul, or into a badly

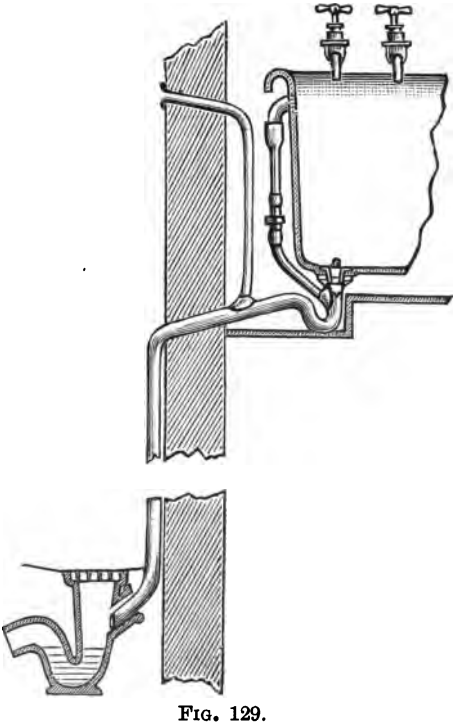


FIG. 129.

formed gully which becomes a miniature cesspool, the contents of which are being continually stirred up, causing foul smells to pass up the waste pipe. It is preferable for the trap and waste pipe to be slightly smaller than the waste plug in order to thoroughly scour them each time the bath water is discharged. And for the purpose of carrying out this self-cleansing action as far as possible, the waste pipe should not

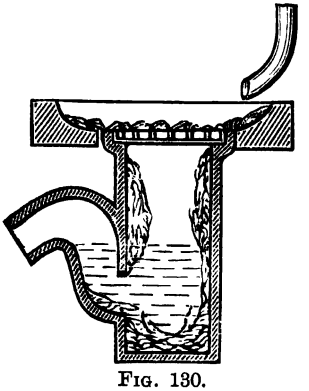


FIG. 130.

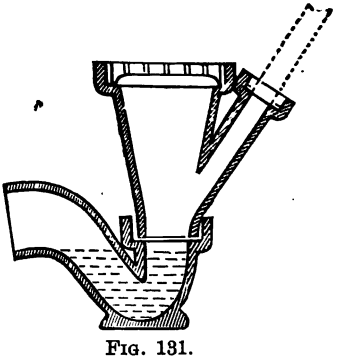


FIG. 131.

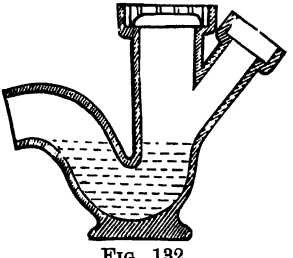


FIG. 132.

discharge into a much larger pipe, like a rain-water pipe, but should either be continued down to the intercepting trap by a pipe of the same size and material, or if an open head is desired it should be specially fixed for the bath waste, and the pipe leading from it not more than half an inch larger in diameter. It is much better, however, not to use the head but to make the pipe continuous and ventilate the upper end near the trap with a pipe not less than half an inch smaller

than the waste pipe, and terminate it at the face of the external wall, as shown in the sketch, Fig. 129. The intercepting trap or gully should also be as self-cleansing as possible, of a round pipe form, with hopper top and side inlets, so that the waste pipe can discharge below the grating, and thus enable the trap to get the full benefit of the waste water flush, and at the same time prevent the splashings which generally occur when waste pipes deliver above the gratings of gully traps. There is a great deal of difference of opinion on this point, although it is difficult to understand why it should be so, considering the numerous instances where the gratings are being continually covered with waste matters, besides dead leaves and pieces of paper, causing the waste water to flow over the surface of the ground.

Recently a notable instance of this kind was to be seen in front of a west-end house. A bath waste discharged into a rain-water pipe in front of the house. The shoe of the rain-water pipe terminated above the grating of the gully trap; this had become covered with dead leaves, with the result that the small area in which the pipe discharged had become full of dirty, soapy water, and it was running over the stone curb of the front railings on to the public footpath. There still seems to be a determination in some places to fix gully traps of such a kind as to ensure the accumulation of filth like that shown at Fig. 130, whereas a gully trap should be as small as possible, and where it has to receive a bath, lavatory, or sink waste, there is no reason at all why it should not be of the form shown at Fig. 131, many of which have been fixed for this purpose during recent years. This trap has a four-inch outlet, and it is reduced to about three inches in the bottom below the water line. Such a trap scarcely ever wants cleaning, because it never gets foul. In any case, the bottom of the gully should not be larger than the drain to which it is connected, and can be round in section all through like Fig. 132.

One is of course well aware of the local bye-laws in many districts, where it is required that all waste pipes should discharge into an open channel two feet away from the gully, the object being to prevent the smell from the foul gully passing up the waste pipe into the house. But where this bye-law is enforced, the most important features, which should render the arrangements as sanitary as possible, are neglected—namely, a trap in the waste pipe under the fitting and a self-cleansing gully trap. The bye-law referred to is really taken from the model bye-laws, which were enacted many years ago, when traps under fittings were rarely thought of, and large filth-accumulating gully traps were almost universal.

But in most cases where trapless waste pipes are fixed, the channel is a delusion, for it provides a larger area to become foul, and does not allow the waste water to flush the gully, as it would if it were to discharge direct into the body of the trap. Consequently the foul emanations from the gully and channel are continually passing up the waste pipe into the house.

CHAPTER XXV.

BATH FITTINGS.

ONE of the most common methods of arranging the waste apparatus is shown at Fig. 133. It is in the form of a combined waste and overflow attachment, which consists of a vertical iron, brass, or copper tube, having a waste valve at the lower end, and an inner tube which acts as a secret overflow. The inner tube also forms the waste plug, and this is lifted by a pull-up knob working through the bath top or through a porcelain slab fixed inside the bath. This

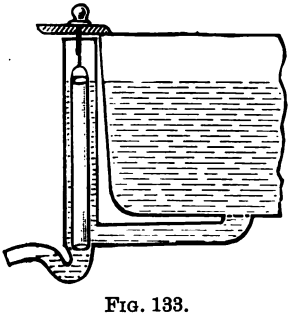


FIG. 133.

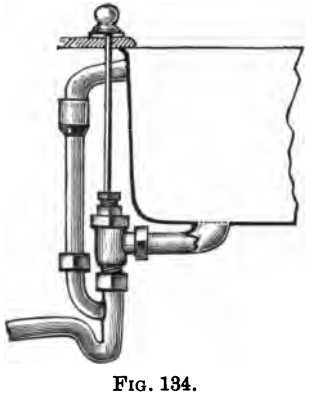


FIG. 134.

arrangement answers its purpose fairly well, and gives a fairly quick discharge, but the disadvantage is that the inside of the vertical tubes gets very foul by soapy matters clinging to the sides, and in many cases this causes a very bad smell in the bathroom. If the tubes were easily accessible, so that they could be cleaned frequently, it would not be so objectionable, but this generally requires the assistance of a plumber to expose the hidden foulness. If the soapy water simply flowed down from the top occasion-

ally, very little harm would come of it, but as it always rises up from the bottom floating matters adhere to the sides as the water is lowered; it therefore never gets flushed, as an overflow like that shown at Fig. 129 would be when the water runs down. A much better form of waste valve, although somewhat old-fashioned, is that shown at Fig. 134. It is merely an ordinary form of valve, which should have not less than two inches way though it, and the grating in the bath should be of equal or greater area. The spindle of the valve works through a stuffing box, and is connected to a pull-up knob by means of a brass rod. The overflow is connected to the outlet of the valve just above the trap, but it should be fitted with a union so that it can be easily taken to pieces and cleaned. The arrangement is further improved

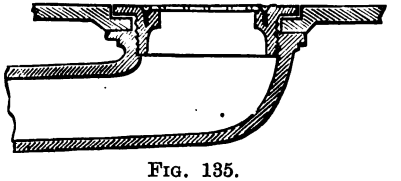


FIG. 135.

by keeping the arm between the bath and the waste valve as short as practicable, and providing for the grating in the bath to be removable when required without disturbing the screw or other connection to the bath; this can be done as shown in the sectional detail at Fig. 135. In the case of a cast-iron bath the grating should be let in a rabbet in the waste arm, and fixed by two small screws to projecting lugs as shown. Another good form of waste valve is shown at Fig. 136; this is constructed on the principle of a basin valve in a valve closet, but instead of the valve seating horizontally it is arranged vertically. By this means a very clear way is obtained, very little obstruction being offered to the passage of the waste water through the valve box. The valve is held tight by a weighted lever, which on plan is something like a horseshoe in shape, both ends being attached

to the square ends of the spindle, which works in gun-metal water-tight bearings through the sides of the box. Where it is desirable to connect the overflow pipe with the waste, an arm is provided on the top of the valve box as shown, but in cases where the overflow is otherwise disposed of a valve without the arm is used.

The overflow pipe should be fixed in such a way as to be easily removed for cleaning. This can be done by making a long socket joint to the overflow arm of the bath, and making the connection to the arm of the waste valve water-tight by a rubber ring inserted between the spigot and socket, as shown in the section. It is supposed in this case that the bath is fitted with an enclosure, and the supply valves are of the ordinary screw-down kind, discharging over the top of the bath; the waste pull would therefore be fixed in the bath top between the supply valves in the ordinary way. And this arrangement, although open to some objections, cannot be beaten from a sanitary point of view.

As the principal object to be attained in the discharging arrangements in any sanitary fitting is the prevention of the accumulation of soapy and other waste matters, where they are likely to become offensive, the waste valve shown at Fig. 137A is one of the best of its kind. It will be noticed that it is really an improvement upon the old style of plug, the discharging area being much larger, and the plug is lifted by a rod and pull instead of a chain; a recess is also formed at the end of the bath for the purpose of containing the valve and rod, as shown by the plan. The overflow is arranged in the casting as shown by the section, and is made

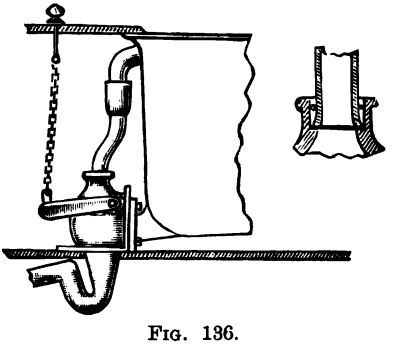


FIG. 136.

accessible for cleaning. Sometimes this form of overflow is dispensed with, and an ordinary overflow pipe is taken direct through the wall into the open air. Another apparatus by the same inventors is made with the overflow and waste discharge combined in one, by means of a vertical tube standing in the recess, the lower end of the tube forming the waste valve, the upper end being connected by a rod to the waste pull. In both cases there is a domical grating at the bottom through which the rod or the tube rises or falls, and which also prevents the waste valve from being lifted out of its place. The

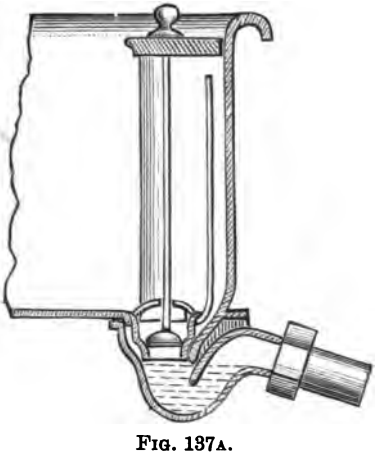


FIG. 137A.

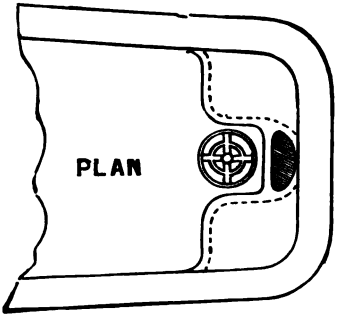


FIG. 137B.

advantage is that the overflow tube can be easily removed when required for cleaning, and as the trap is fixed close to the bottom of the bath and immediately under the waste valve, there is no part which is likely to become foul by being neglected.

With regard to the various methods employed for supplying baths with hot and cold water, there can be no question that the most sanitary is that of fixing the valves over the top of the bath so that the dirty water cannot come in contact with the supply valves and services. The principal objection to this plan is that a large amount of steam escapes into the

bathroom, and where the bath is fixed in a dressing-room the condensation of steam on the walls, ceiling and furniture is generally regarded as a nuisance. But where the room is used for a bathroom only, very little harm, if any, is done, more especially if the walls and ceiling are made impervious, as they should be, by glazed tiles or some other damp-resisting materials. With the object of preventing the escape of steam as much as possible the hot and cold water is arranged to pass through a kind of mixing chamber and conveyed by one pipe either over the top or, in most cases, through the side of the bath, near the bottom, as shown at Fig. 138. The result of the latter plan is that the inlet pipe is submerged while the bath is in use, and under conditions which often exist it is possible to draw dirty water from the bath into a sink or other fitting which is supplied with water by the same pipe at a lower level. As a matter of fact, contamination of water has been known to have occurred by this means. If, for example, the main cold water service pipe is rather small, it is probably three-quarters instead of one inch, or it may be, where there are several branches on the main pipe, it is one inch diameter instead of being one and a quarter or one and a half inches. The bath is filled, and as the inlet is below the surface of the water it is impossible to see whether the supply valve is shut off or not; consequently, it is often left partly on, owing, probably, to some defect in

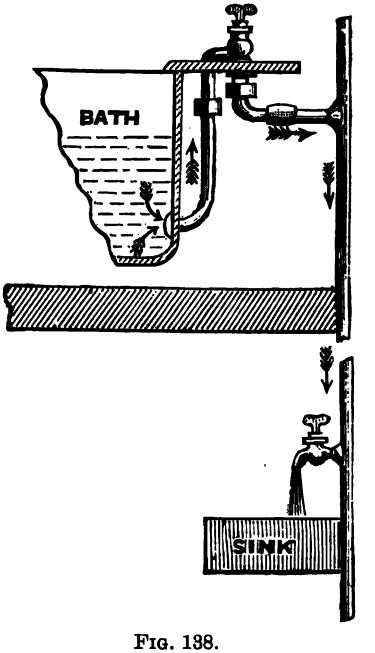


FIG. 138.

the fitting. Then, while the bath is in use, or when the water is left in for some time after, as it is in many cases, some one opens a valve on a sink below, with the result that the water rushing past the branch pipe to the bath causes an exhaustive action, and syphons the water from the bath into the main service; the amount will, of course, depend on the length of time the lower valve is kept running, but ever so little may, under circumstances that may be imagined, especially if the water is used for drinking, as is quite possible, be the cause of something serious.

It is important, therefore, in all cases of this kind, that the services should be arranged in such a way as to make occurrences of this kind impossible, either by the main service pipes being ample in size, or, better still, to adopt some means to absolutely prevent the dirty water running back into the main service. One has often thought that the manufacturers of these fittings ought to arrange the valves so that such a defect could not take place under any circumstances. This could be done by fixing a small air valve on the upper end of the outlet pipe, or a small air pipe taken up a sufficient height would answer the purpose better.

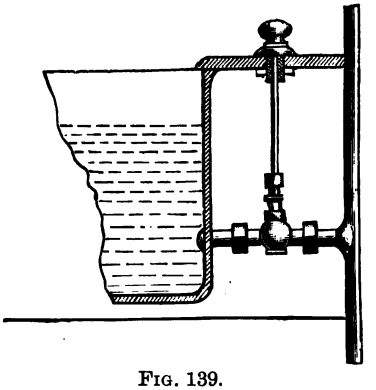


FIG. 139.

In the case of the supply valves being fixed at a lower level, like that at Fig. 139, the fault is worse because no syphon action would be necessary; the water would simply gravitate back to the main service pipe, where a lower valve is opened, so that the absence of some means such as an efficient check valve to make the return of the water impossible would make such an arrangement dangerous.

CHAPTER XXVI.

BATH FITTINGS (*Continued*).

REFERRING to my remarks on the possibility of the dirty water in the bath flowing back through the supply valves into the main service pipes, some may suggest that where the supply valves are fitted with loose valve seating or "jumpers," as they are sometimes called, these would fall back in their place and prevent the return of the water. But this would depend on the valve being in good repair; if the seating was worn, and therefore unsound, the water could run back, more especially as it would depend only on the weight of the "jumper" and the very slight pressure of water in the bath to keep it tight. And when the jumpers are pinned to the spindles, as they are in a very large number of well-made valves, they are no more secure against the return flow of the water when accidentally left on than the old-fashioned stop cock.

Amongst the various methods of arranging bath supply valves those shown at Fig. 140 are some of the kinds used for discharging the water below the top of the bath. In the case of A the supply valves are fixed below the top of the bath, and are joined together by a branch pipe, which has an outlet connected to the supply nozzle in the end of the bath.

The capstan heads are connected with rods, which form a continuation of the valve spindles through the bath top.

Those at B are combined to a metal plate, under which is a hollow chamber communicating with the outlet pipe in the

centre; this is connected by either a brass or lead pipe to the supply nozzle, at the end of the bath, at any depth required. To the same plate is also fitted the waste pull, as shown in the plan; another method is shown at C; this, it will be seen, is a somewhat similar arrangement to A, excepting that the valves are above the bath top instead of below.

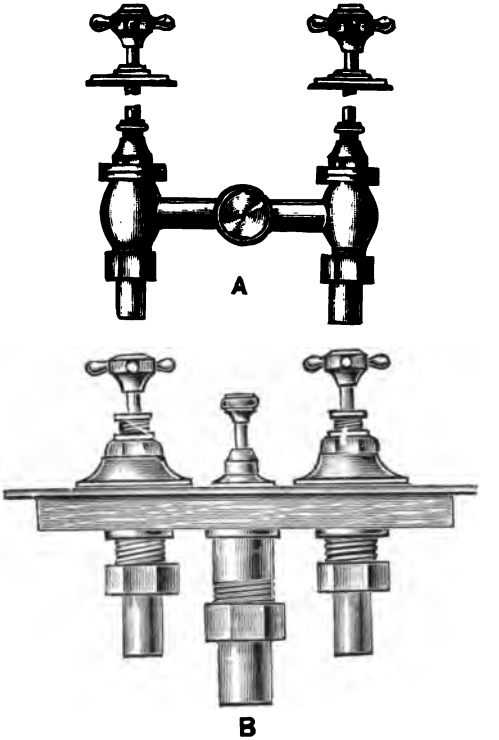


FIG. 140.

Having in view the disadvantages of supplying the water below the water level of the bath, the two latter sets of valves are in my opinion the best to use, if such an arrangement is preferred.

The style of valves for discharging the supplies over the top are well known; those shown at Fig. 141 are typical forms.

A is a very good arrangement if well made, and answers its purpose satisfactorily. When separate inlets are required, that shown at B is a very convenient set of valves. If the valves are required entirely separate, C is one of a kind that is now used very extensively.

Some few years ago half and quarter turn valves, with

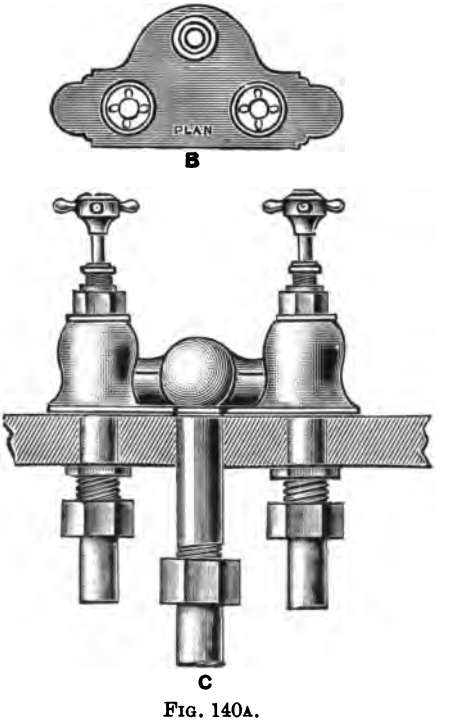


FIG. 140A.

lever handles, were used to a very large extent. But as it was necessary, in order to open the valve wide enough to allow a sufficient amount of water to pass, to make very quick threads on the spindles, the extra pressure which the levers enabled one to exert on the seatings soon cut through the rubber seatings. And where a harder material is used, such as leather or woodite, the slow threads will not hold the valve

down tight enough to prevent its leaking. The ordinary screw-down valves with capstan heads are therefore found to be more durable and easier to shut off.

The greatest difficulty is generally experienced with the hot supply valve, especially where the hot-water apparatus is more than usually powerful, and the water is continually

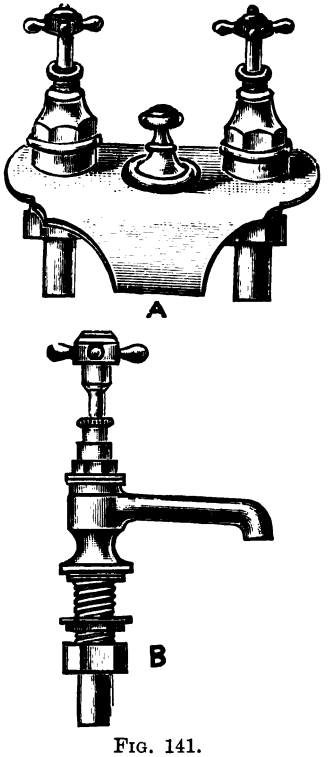


FIG. 141.

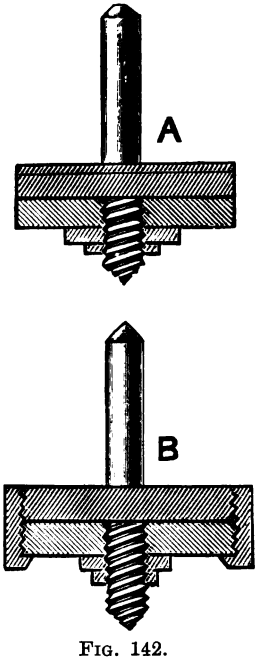


FIG. 142.

kept at a high temperature. In any case there should be a stop valve on the bath service pipe as near the supply valve as possible and easily accessible, so that the water can be readily shut off when repairs are required. And there is an advantage when the persons in the house can shut off the hot water by a stop valve when the bath is not in use, and

thus prevent the damaging of the enamel by the continual running of hot water over the inside of the bath.

There is one point about the construction of valves which is very important, especially with regard to those used for hot water. In most of the common valves the rubber seating is simply fitted to a metal disc and secured by a nut similar to that shown at Fig. 142 A. And so far as the cold water is concerned it answers its purpose, but in hot-water valves the rubber or other forms of seatings become swollen and are spread out by the pressure brought to bear upon them, with the result that they very soon require renewing. If, however, the seating is secured by a metal ring in the manner shown at B, as is the case in many of the better class of fittings, it adds greatly to the durability of the seating material. By this arrangement the rubber cannot spread, and although the swelling of the material outwards cannot entirely be prevented it does not affect the durability to any great extent.

CHAPTER XXVII.

LAVATORIES.

THE sanitary principles which govern the form and arrangement of baths should also apply to lavatories in nearly every particular, especially with regard to the rule that any part of the fitting which is likely to get foul, and therefore become a nuisance, should be easily accessible for cleaning purposes. There are many of the modern lavatory fittings which do not comply with this requirement. As an inexpensive fitting, a plug basin having an accessible overflow similar to that shown at Fig. 143A can be made as satisfactory from a sanitary point of view as the most costly fitting.

The plug and chain is not, of course, the most desirable waste arrangement, but this is a matter of convenience and appearance, and does not affect the sanitary question. Compare for instance a lavatory basin and secret waste plug with a plated pull through the top of the slab like Fig. 144 with that at Fig. 143A. The former to outside appearances is everything that can be desired, the water discharges fairly quick and all parts that are seen can be kept clean. But the chamber at the back in which the standing waste and overflow tube is fixed becomes very foul, much more so than most people suppose, and as it is not seen and is inaccessible, except by unscrewing some of the parts which servants are not expected to do, a foul smell is being continually given off, and in the event of infection from some skin or other disease, there is no means by which the foul part can be

properly cleaned or even disinfected. But in the case of the simple arrangement at Fig. 143A every part that is likely to get foul is accessible. In the old style of lavatory basin the

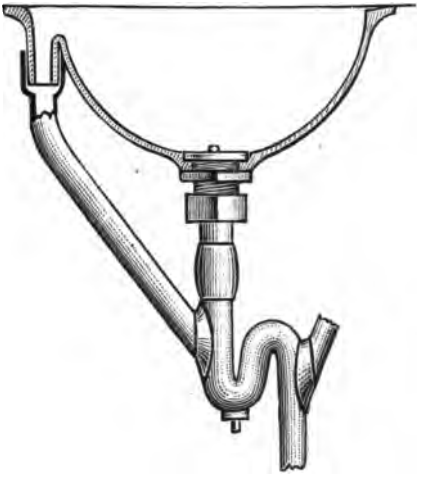


FIG 143A.

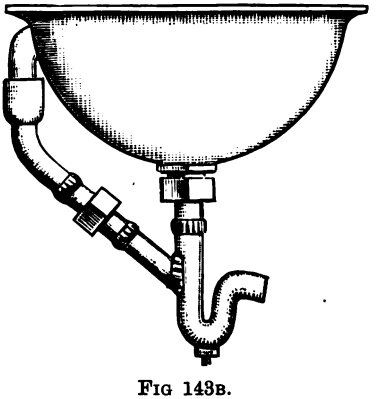


FIG 143B.

overflow is not easily cleaned because it terminates with a grating in the side of the basin like that shown at Fig. 143B Although this can be improved by fixing a union as shown in the overflow pipe, so that it can be disconnected oc-

casionally and cleaned, it is not so objectionable as the large cavity which is never flushed by a downward flow of water from its upper end. The overflow, which is formed by an opening or slot in the side of the basin, as shown, gives ready access for a brush, so that it can be cleaned regularly.

With regard to the trap—and there is no need to repeat the argument as to its necessity—it should be self-cleansing, and this is easily accomplished by having a waste plug as

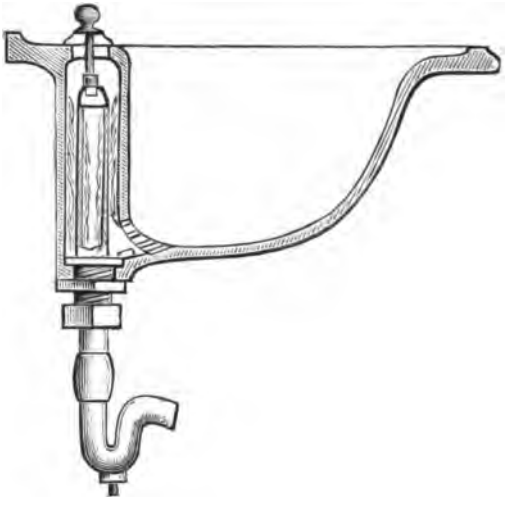


FIG. 144.

large as possible and fixing a trap a trifle smaller, in order to insure the trap being fully charged and completely flushed out when the waste water is discharged. It is absurd, for instance, to fix a two inch or even an inch and a half trap in connection with an inch waste hole. The two-inch trap is four times the area of the waste hole, and the inch and a half is more than twice as large. The only advantage, if it can be so regarded, is that no ventilating pipe would be necessary to prevent syphonage where the trap is so much larger

than the waste outlet, but such a view should not be taken when work has to be done properly.

It follows, therefore, that if the whole is to be as self-cleansing as possible, the waste pipe should be no larger than the trap, and this should be continued the same size either to the main waste pipe or to the gully trap into which it should discharge, as before explained, below the grating.

It seems strange in these days that it should be necessary to call attention to the overflow connection to the trap, but one is frequently finding cases where the overflow pipe is branched into the waste pipe beyond the trap, like that shown at Fig. 145, and thus rendering the trap useless. It would not be so surprising if it was always found in conjunction with bad and tinkering work, but in some cases the work is well done and the joints neatly wiped, which shows some skill as a workman, but a serious lack of judgment and knowledge of the purpose of the fittings.

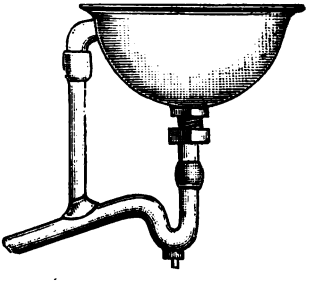


FIG. 145.

Many years ago plumbers used to make up their own lavatory waste fittings of lead with a brass valve, and flanged in the manner shown at Fig. 146.

The basin had no overflow connection, as this was formed secretly in the fitting as shown. The basin had a large waste hole to which was fitted a large grating and fly nut, this nut being wiped to the lead arm under the basin.

The valve was known as a ground in "feather valve" which was attached to a rod or wire, and this was connected to a snake chain passing over a pulley wheel, and connected to a pull working horizontally through the marble riser of a shelf behind the lavatory. It will be seen that when the basin was full the water would run over the stand pipe into

the overflow pipe and thence to a connection below the waste valve. As a quick-discharging, rapid overflow, and easy working arrangement, there was nothing nor is there now anything to beat it. In fact some of the most expensive fittings are still made on the same principle. But the objec-

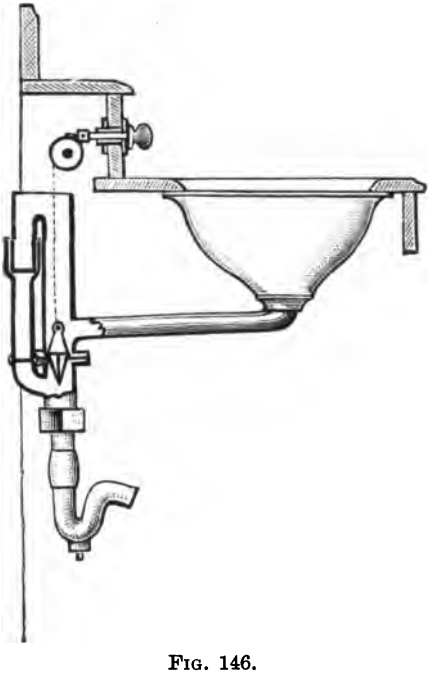


FIG. 146.

tion to them is obvious; the stand-pipe, the overflow and the connecting arm to the basin get very foul and cannot be kept clean. There are still many of the kind in use either with lead, brass, or copper pipes, but they are gradually being replaced by more modern fittings.

CHAPTER XXVIII.

LAVATORY FITTINGS.

FOR many years the "tip-up" form of lavatory basin was received with a large amount of favour, and there can be no doubt that when it was first introduced it was a great improvement upon most of the fittings then in use. The principal point in its favour is that the contents of the basin are very quickly discharged, and in such a way that the soapy sediment does not remain on the sides of the basin. But as it is necessary to use an additional basin as a receiver, the soapy matters adhere to this, and as it is very difficult to get at for cleaning purposes in most cases this lower basin is found to get into a very filthy condition. In most of these lavatories it is very difficult to remove the upper basin in order to properly clean the lower one. By the latest arrangement, however, which, by-the-bye, was brought out by the original inventor, the basin can be lifted out of its bearings without any difficulty. This is done by fixing projecting studs in the sides of the basin, and these are made to fit into semi-circular slots at the ends of the bearings. By this arrangement the old loose brass lugs and lead pins are dispensed with.

Where tip-up lavatories are required, in addition to the improved bearings, the receiver should have an outlet at the back, as shown at Fig. 147, and an anti-splash guard on the front of the receiver as shown. This almost completely prevents the disagreeable effect which the ordinary form of fitting produces; for when the basin is tipped up quickly, the water strikes the back of the receiver, passes across the

bottom, up the front, and over the shirt front of the person using it; but when the receiver has a straight back, the water falls to the bottom direct over the outlet grating. This grating should have as large an open area as possible; in many cases the gratings are earthenware, having a few small holes, which are not more than about one-third the area of the trap and waste pipe. It is much the best plan to use a brass cobweb grating, and connect the outlet of the receiver by a

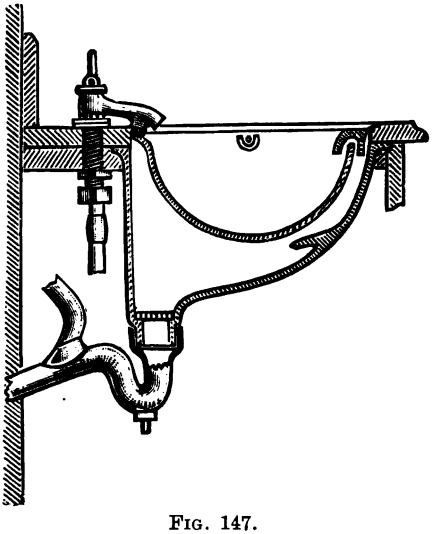


FIG. 147.

cone piece to a two-inch self-cleansing trap and ventilated waste pipe, arranged as before described.

In some cases one finds that the area of the outlet grating has been purposely reduced in order to check the discharge, as it was found that the trap lost its water-seal by syphonage. The fact that the trap required ventilating was either not realised, or the necessary expense avoided. But as a quick discharge is one of the advantages claimed for this kind of fitting, it will be generally found that when a two-inch trap is used in connection with a large outlet grating, the ventila-

ting pipe of the same size as the waste pipe is necessary to prevent syphonage. Although it is practically impossible to arrange a waste-discharging valve to discharge the contents of the basin so quickly as a "tip-up" basin, this must of course apply to the upper basin, and not the receiver, for the advantage gained in the one is lost in the other, so that when the advantages are compared the receiver must not be lost sight of, as it is almost invariably.

There are several kinds of waste valves now in use which

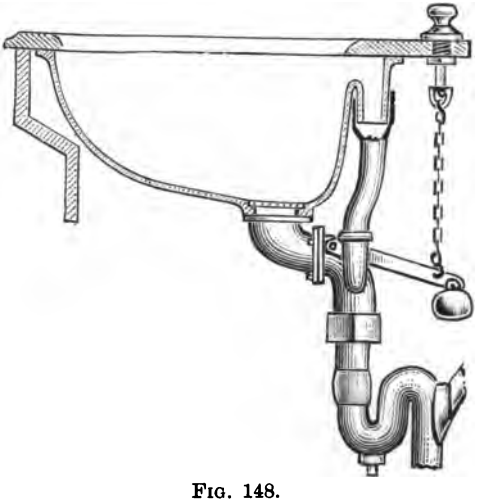


FIG. 148.

discharge the waste water from a single basin lavatory as quickly as can be desired, although as a rule an inch and a half trap and waste pipe is considered large enough for the purpose. Some can be fitted to an ordinary basin having a large waste hole like Fig. 148, but in order to render the fitting sanitary the basin should be provided with an open overflow arm so that it can be easily cleaned. It will be seen in the sketch that the waste valve is made on the same principle as the valve to a valve closet, so that when the lever is raised by the pull through the lavatory top, the valve

opens outwards and gives a full way for the waste water to discharge. The overflow is connected to an arm in the valve box provided for the purpose, just below the valve. The pull works very easily and the valve is very durable, and when the rubber seating requires renewing it can be replaced very easily.

Another excellent quick-discharging waste valve is shown at Fig. 149; this is similar in every respect to the bath waste valve described at Fig. 137. It is really a modification of the plug waste, but without the objectionable features. The

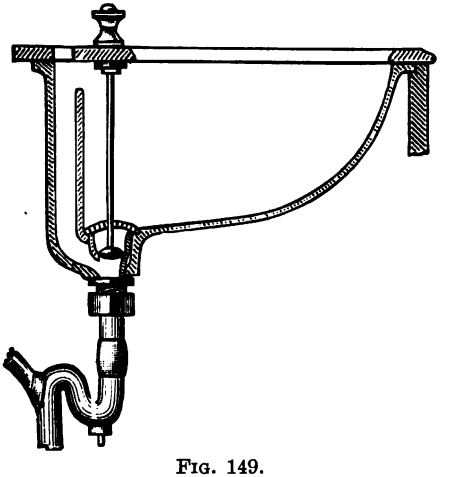


FIG. 149.

plug is placed below a domical grating at the bottom of the basin, and is raised and lowered by a nickel-plated rod attached to a pull-up knob either on a projecting shelf formed in the marble slab, or an earthenware shelf is formed with the basin. At the back of the basin is a recess in which the valve and rod are placed outside the line of the basin, but easily accessible. In some cases the basin is formed somewhat triangular in plan, as shown at Fig. 150; the rod and valve are then in the back angle well out of the way. The overflow, which is open at the top, is formed at the back of

the recess, and discharged just below the waste valve, as shown in the section. This is undoubtedly one of the quickest discharging lavatories in the market at present, and is generally regarded as the most sanitary of fittings.

With regard to the general arrangement of lavatory fittings, the tendency in the present day is to dispense with wooden enclosures and fix the basin and slab on cantilevers or brackets, the principal object being to avoid the accumulation of dirt within the enclosures; and in the opinion of some persons the open style of fitting has much the best appearance, although, as in all other matters of this kind, opinions differ considerably. Much of course depends on the description of the fittings used, some of which are entirely unsuitable for fixing without enclosures, because the arrangement of the trap, waste and service pipes are often very unsightly, and, excepting in rather expensive fittings, they require some kind of screen or enclosure to make them acceptable.

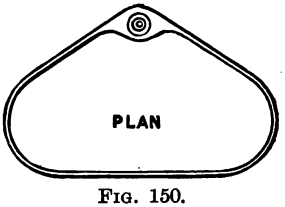


FIG. 150.

Much of course depends on the way in which the trap and waste pipe are fixed and the workmanship in connection with them. A very inexpensive fitting fixed on brackets is shown at Fig. 151, and where the trap is kept as close up to the outlet as possible, and the waste pipe and air pipe are neatly arranged and then painted with white enamel, very little fault can be found with it. In the more expensive kinds of fittings, the trap, waste and service pipes which are exposed are made of brass and nickel plated, which, in addition to the first cost, need constant cleaning in order to keep up their superior appearance. Where lavatories are fitted with marble slabs and no enclosure is provided, light metal legs are often preferred similar to that shown at Fig. 152. These are made either with a bronze finish or nickel

plated, and are generally regarded as adding a more substantial appearance to the fitting.

Another form of lavatory basin which is being used somewhat extensively during recent years, where something strong is required, is made of white glazed fire clay in the form of a "corbel"; this is built into the wall and requires no other support. One of the kind is shown in section at Fig. 153. In this case the waste is discharged by a rubber plug attached to a chain; the overflow is made in the material which forms the basin, and is accessible from the opening in the top as shown in the section. Another kind has a copper trumpet-

FIG. 151.

FIG. 152.

mouthed standing waste, which fits into a recess at the back of the basin as shown in the plan B. The standing waste pipe of course acts as an overflow, and as it can be easily removed it can be cleaned without difficulty. With regard to the supply valves for lavatories, the ordinary screw-down form of valve seems to be most in favour. The cam action and some other kinds of spring valve are useful where they are likely to be carelessly used and a waste of water has to be considered. But most people object to hold the levers of supply valves while the basin is filling, so that the screw-down valves are being used almost universally, and where

they are required for private houses there should be no reasonable objection to them. In schools, asylums and institutions, however, where the persons who use them cannot be relied upon to shut them off, a self-closing valve is the best kind to use.

In some places water companies will not allow this kind of valve to be fixed, because they do not consider them so substantial as the ordinary screw-down form. But in many cases this is a mistake. There are of course badly made spring valves as well as other kinds, but if the self-closing valve is of a good form and well made, they are really more durable and far less trouble than the screw-down kind. The reason is that the self-closing valve under a medium pressure is always subjected to a uniform pressure on the valve seating, and when properly adjusted will not wear the seatings out nearly so quickly as many of the screw-down kind, which are screwed down at various pressures by different persons using them, with the result that the seatings are cut through in a very short time. Much of course depends upon the construction of the valve, and the capped seating as referred to at Fig. 142 is an important feature in this, as in all other kinds of screw-down valve. The screw-down metal-to-metal form of valve is being used very extensively lately; these are fitted with ground seatings which do not require any rubber, leather, or any other seating of this kind. But these, like all

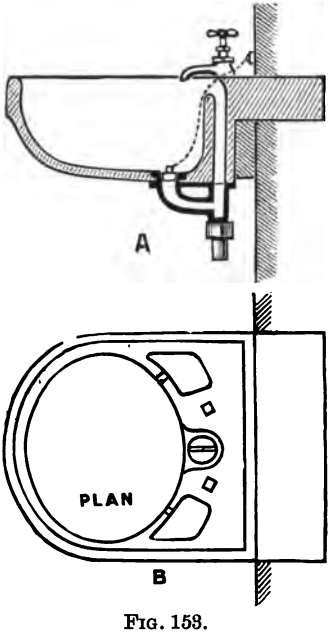


FIG. 153.

other valves, wear out, and the difficulty is they cannot be repaired in their place, but must be taken out and sent to the makers. This of course involves a large amount of time and expense, even if a pair of duplicate valves are kept in stock for replacing those in use when required.

My own experience is that these valves last a long time generally when under moderate pressures of water, but under somewhat high pressures they frequently leak very badly after but a few months' wear. Some certainly behave better than others, but when they do let by the repairing or renewing is costly and often troublesome.

CHAPTER XXIX.

SINKS.

SINKS are an important form of sanitary fitting which are often found to be in a very unsatisfactory condition both as regards their material and arrangement. In sculleries, where the greater part of, at least, the vegetable food is prepared, the sinks are often in a most deplorable state, and the effluvia arising from them are disgusting, not only on account of defective drainage arrangements but also owing to the absorbent nature of the materials of which the sink and its surroundings are composed.

One of the worst materials for scullery sinks, from a hygienic point of view, is wood, particularly that of the softer and absorbent kinds. And although many people are prepared to bring forward strong arguments in favour of bare wood for this purpose, especially that it is not so likely to cause the breaking of plates, dishes, etc., there is really very little force in the arguments, because where sinks are required to hold water for the purpose of washing and rinsing, metal linings are little, if any, more destructive than those of uncovered wood, which, as a rule, is not durable, and is never properly cleansed.

With regard to the ordinary shallow scullery pot sink, this, as a rule, up to a few years ago was made of a solid Yorkshire stone of varying degrees of hardness.

Some are found cut out of a close fine-grained sandstone which is very durable and practically non-absorbent. But this is the exception, not the rule; for generally they are

soft and quickly worn away, and in a short time full of holes, besides being porous, and therefore clogged with foul greasy matters which cannot be effectually removed by cleansing in the ordinary way: consequently there is always a strong smell arising from this kind of sink, which is very disagreeable.

And, to make matters worse, the waste pipes, even at the present day, discharge over the gratings of large gullies in the scullery floor, immediately underneath the sink. These gullies are often of what are called the grease-trap form, and, therefore, the very antithesis of a self-cleansing trap. The result is the accumulation of decomposing greasy matters

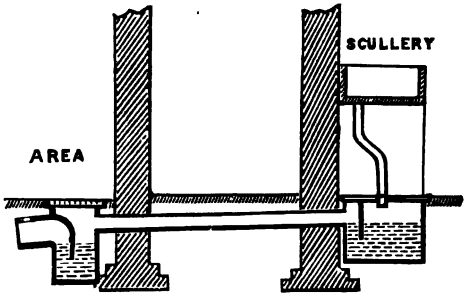


FIG. 154.

and stale green water, which, on being stirred up by the incoming waste water, is sufficiently offensive to be quite unbearable to those who have not become used to it, as many seem to do. As an instance of what extraordinary things are done in the name of modern sanitation, Fig. 154 is a sketch of a scullery sink arrangement which has been constructed during the last few years. The sink is certainly of glazed earthenware, but the waste pipe is untrapped and discharges into a fairly large size rectangular form of grease trap under the sink, and the outlet of this is taken into an ordinary gully in the area.

The grease trap is supposed to be cleaned out once a

week, but in order to avoid the smell which it causes it ought to be cleaned out about twice a day.

The most extraordinary thing, however, is, even supposing the grease trap is necessary, that it should be fixed inside the scullery, when it could easily have been placed outside the house, in the place of the gully in the area, where its offensiveness would not be so dangerous and noticeable.

My own opinion, which has been confirmed by considerable experience, is that, at any rate in small houses, particularly where the cleaning out is likely to be neglected, the grease-accumulating trap is a mistake.

If a flushing gully can be fixed, all well and good ; but

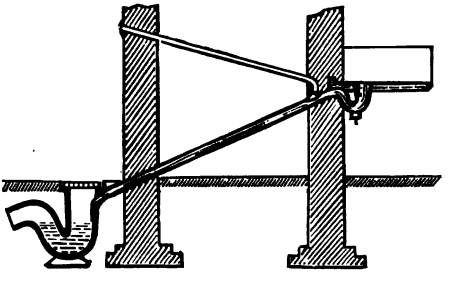


FIG. 155.

if not, a self-cleansing gully, as already described in connection with bath and lavatory waste pipes, is the proper thing to use.

In such a case as Fig. 154, therefore, the grease trap should be entirely dispensed with, the waste pipe fitted with a self-cleansing form of trap and continued through the external wall, and arranged to discharge below the grating of a round pipe form of gully trap in the manner shown at Fig. 155 ; and as the waste pipe in this case is considerably more than four feet long, it should be ventilated by an air pipe taken through the external wall as shown—not that syphonage is likely to take place where the trap is connected

to a sink of this kind, but on the principle that all dirty pipes should have a current of air passing through them from and to the open air.

An important point also is—as in the case of the other fittings before described—that the outlet of the sink should be at least equal in area to the bore of the trap and waste pipe; and it is better still to have the waste grating nearly, if not quite, twice the diameter of the trap, so that a cone is necessary on the inlet of the trap, as shown in the detail section at Fig. 156.

FIG. 156.

One of the objections to traps in waste pipes is that they are continually getting stopped up; but where the above plan is adopted this is rarely, if ever, the case, because the large outlet from the sink ensures a full flush of water through the trap and waste pipe, which not only prevents an accumulation of waste matters in these, but also has sufficient flushing power on the gully, providing the waste pipe is arranged as shown to keep it free from grease or deposit. In such a case the waste pipe and body of the trap should be two inches and the ventilating pipe one and a half inch. But if the outlet grating of the sink is small the trap and waste should be correspondingly less.

CHAPTER XXX.

WASTE PIPES.

IT may be remembered that the series of fittings that have been described hitherto in these pages are supposed to be of a kind which are suitable for a small villa residence; it will therefore be advisable to leave the description of the more elaborate kinds of sinks which are generally fixed in a large mansion until all the sanitary arrangements of a house of this kind are considered. The only other kind of sink likely to be required in a small house is one suitable for housemaids' use on the bedroom floor. Some few years ago it was customary to fix a kind of combined housemaids' sink and slop sink, the latter being used principally for bedroom slops. The fitting consisted of a slate sink of a rectangular form, with an extension at one end under which was fixed a short hopper basin and earthenware trap having a slip joint connection to a branch of the soil pipe. The waste pipe from the wash-up sink was generally taken into the supply arm of the slop sink. In many cases it was found that the hot water from the wash-up sink, which passed through the slop sink to the lead soil pipe, caused considerable expansion and contraction, and quickly produced fractures in the lead pipe. This led to the practice of discharging the slop-sink waste into an ordinary waste pipe which delivered into an open gully. But the effluvia which escaped every time a pail of slops was discharged were so offensive that, combined with the dirty condition of the basin and trap owing to insufficient flushing arrangements, slop sinks were

regarded as insanitary and in every way objectionable fittings. And when the pedestal and slop-top form of water-closets were introduced, slop sinks were considered to be quite unnecessary. In larger houses slop sinks are still fixed, but under quite different conditions and in improved forms, as will be shown later on.

But so far as the ordinary housemaids' sink is concerned,

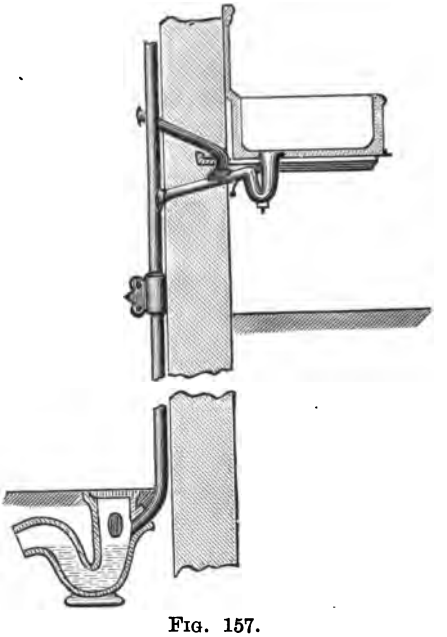


FIG. 157.

this should consist of a white glazed fireclay sink about 30 inches × 20 inches × 10 inches, fixed on galvanised iron cantilevers pinned into the wall, or, in the case of a wooden partition, on brackets so that the floor beneath is quite clear of legs for the support of the sink. The sink should be fitted with a large rubber plug, brass washer and chain, a two-inch self-cleansing trap, and a two-inch lead ventilated waste pipe with expansion joints fixed on the external wall,

and arranged to discharge below the grating of a self-cleansing gully trap as shown at Fig. 157. The usual economical custom is to discharge the waste pipe into a rain-water head in the manner shown at Fig. 158. The result of this arrangement is that the rain-water pipe becomes fouled with soapy and greasy matters; these emit unpleasant smells, which are a nuisance to persons sitting near an open window or sleeping in the same room when the window is open. If the pipe could be reduced to two inches diameter, then the open head would not be so objectionable, as the waste water would have sufficient scouring effect to keep the waste pipe fairly clean. But as this would not be practicable in most rain-water pipes, it follows that all waste pipes should discharge into down pipes which are used for no other purpose and reduced to the smallest practicable size. And instead of fixing open heads, junctions are much to be preferred in cases when fittings from two or more floors are connected to one pipe, as shown at Fig. 159; and in the case of one fitting the waste pipe which passes through the wall should be connected to the down pipe by means of a bend as shown at A. Excepting where two or more waste pipes are connected to the iron main waste pipe at about the same level, an open head is quite unnecessary, and even then the junctions, like Fig. 159, would make a better job in every respect; while in the case of lead waste pipes the joints should be soldered as shown at Fig. 160. The objections to lead waste pipes are that they are expensive, and when fixed in long lengths with soldered joints the excessive

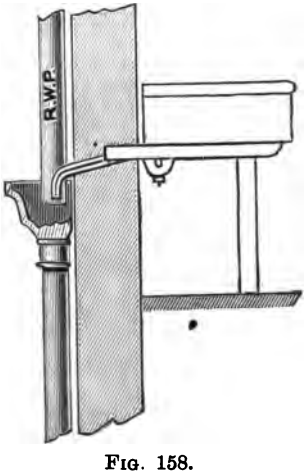


FIG. 158.

expansion and contraction breaks the pipe when hot water is discharged from the fittings. There is, of course, no question about the expense, but when good, substantial, clean and durable material is appreciated, and more especially where a particular design or neat appearance is required, lead waste pipes can be fixed in such a way as to render them practically indestructible—that is, by allowing the lead to expand and contract freely by means of expansion joints instead of ordinary soldered joints. If iron pipes are used they should be coated, galvanised, or glass lined, in

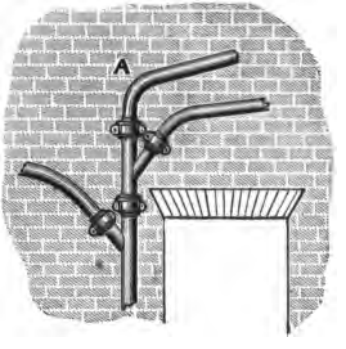


FIG. 159.

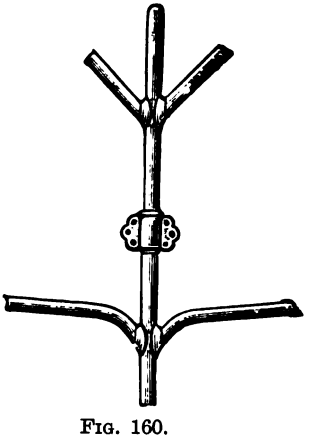


FIG. 160.

order to form as clean a surface inside as possible and protect them from oxidation.

With regard to the expansion and contraction of lead waste pipes already referred to, the evil effects can easily be provided against by a very simple arrangement. The general idea is that lead pipes must necessarily be joined by soldered joints, but in the case of disconnected waste pipes, this is not at all necessary or advisable—at any rate where the pipe can be fixed outside the house.

The expansion joint consists of a long socket formed on the end of a length of lead pipe, and made just large enough

for the spigot end of the next length to slip easily into it. As lead pipes of a size that are generally used for waste pipes are made in twelve-foot lengths, the usual plan is to cut them in two pieces of six feet each, and form a socket about six inches long on one end. Where there is no necessity to make the socket joints absolutely air-tight so as to stand a test under pressure, a plain socket similar to that shown at Fig. 161 A is all that is required. The tacks, it will be seen, are soldered to the socket, and the spigot end of the next length is allowed to enter only about four inches, thus leaving space enough for a certain amount of expansion to take place between the end of the spigot and the shoulder of the socket. If this precaution were not taken, and the spigot allowed to rest upon the shoulder, the force of expansion, which is practically irresistible, would cause the lengths between the sockets to bend on one side or the other, and look very unsightly, although no more harm would come to it. In order to make the sockets clean and regular, a boxwood or other hard wood socket mandrel is used, like that shown in Fig. 161 B. This is driven in after the end of the pipe has been roughly opened by means of a bobbin of a slightly smaller diameter than the mandrel.

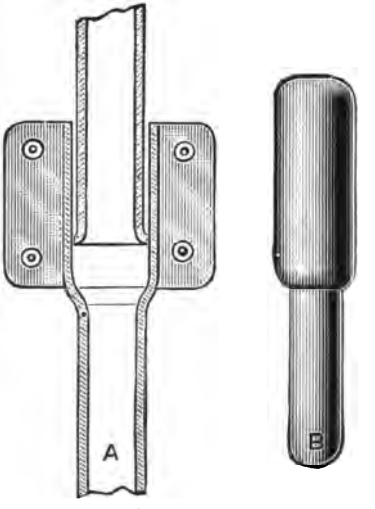


FIG. 161.

If the socket should be a little larger than the spigot, the end of the latter should be opened, so that it fits the socket exactly, and this will make the joints as nearly air-tight as is necessary in most instances. And even when the joint is

not quite air-tight when newly fixed, after it has been in use a little while, the capillary action between the socket and spigot will cause sufficient soap matter to be drawn up between the two surfaces to render the joint air-tight, and prevent the escape of foul air from the pipe. This is of course important when the pipe has to pass down close to open windows. When it is considered desirable to make the joints sound enough to withstand a test, the socket should be made a little larger, so that a rubber ring can be

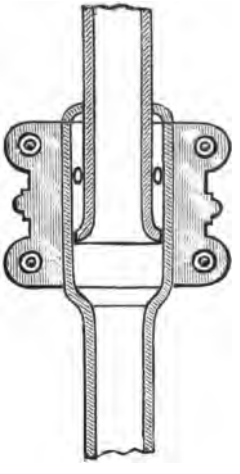


FIG. 162.

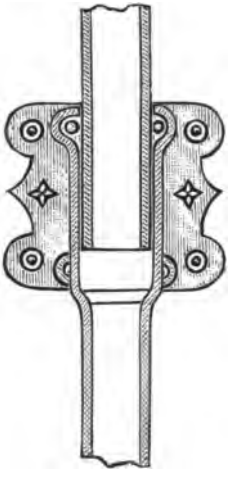
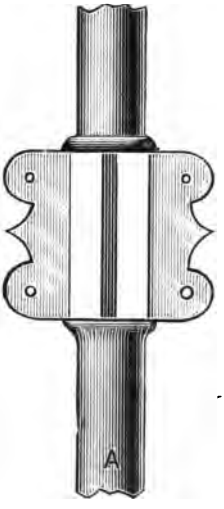


FIG. 163.

forced into it as shown at Fig. 162. In this case it is all the more important that the end of the spigot should fit close to the socket as shown, in order to prevent the rubber ring from slipping off and falling into the bottom of the socket.

The objection often raised to this method is that the rubber will soon become hard and useless, but in practice it is found that, although the rubber is, of course, affected by the heat, it does not dissolve or become worn, but remains as

a kind of hard packing ring, and answers its purpose for many years. Asbestos rings answer the purpose very well and are not affected by the heat, but they are not so easily pressed into the socket in the first place.



When the sockets are required of an ornamental form, with astragals and tacks, the ring can be placed in a hollow bead formed on the top of the socket as shown at Fig. 163. By this method the spigot is made to fit the socket exactly, and the ring is securely retained in its place by a lead ring placed on the top, and held in its place by the edge of the socket being worked over the ring as shown in the section. This bead then forms the upper astragal, and a cast lead astragal is soldered on the bottom of the socket. The tacks are soldered on in the ordinary way by wiped seams, as shown at Fig. 164. As shown at the section B the backs of the tacks and the face of the solder should be in a straight line, and fit close to the wall, the soldered edge of the tacks being bent in order to form a sinking for the solder and thus form a substantial seam.

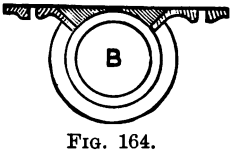


FIG. 164.

CHAPTER XXXI.

WATER SUPPLY.

THE next and last subject in connection with a small villa residence we have to consider is the water supply. It is supposed in this case that the water supply is derived from the water company's main, and that the supply is constant. It is therefore unnecessary to consider the evils of an intermittent supply, as this is nearly a thing of the past. It may, however, be well to point out that the constant supply system is not absolutely reliable, for many things may occur to temporarily shut off the supply, which, in the absence of reasonable precautions, may cause much inconvenience, if not something worse. Many people have a horror of storage cisterns, and seem to think that they cannot exist without becoming sources of contamination and accumulators of foulness. But they seem to forget that in country houses, where the water is derived from a well, storage cisterns are absolutely indispensable, and they can be arranged in such a way as to be not only harmless but in some cases beneficial to the water supply, especially where the water is charged with solid matters in suspension, which require some means to enable the particles to precipitate, instead of passing direct to the draw-off valves.

But, independent of that view of the matter, my own opinion is that the absence of a reasonable storage of water is a mistake, because not only is it a serious matter for any house—particularly a large one—an hotel, or an institution to be deprived of its water supply even for an hour; but in

the case of baths, lavatories and other sanitary fittings it is always more satisfactory to supply the fittings from a cistern which supplies the water at a uniform pressure instead of connecting them direct to the main supply, the pressure of which is often very excessive and generally variable from hour to hour, according to the amount of water being used in the town or district.

Where the water is good and free from suspended matters it can, of course, be drawn direct at sinks for dietetic purposes, and there is an advantage in doing so. But for all other purposes it should be drawn from a storage cistern, which should hold sufficient water to last during one day at least in case of the main supply failing.

This is more especially important in the case of the cold water supply to the hot-water apparatus, because the consequences may be far more serious than the mere inconvenience of the water supply being for a time discontinued.

With regard to the materials of which storage cisterns should be constructed, this, of course, depends on circumstances. If no drinking water is drawn from them, the question of metallic poisoning need not be considered, at any rate from that point of view; although it must be remembered that in many cases the causes which produce metallic poison also affect the durability of the material used.

Until the last few years lead was considered to be the most suitable material for casting or lining cisterns, and for the purpose of storing most hard waters there is no metal more suitable, and as to durability, providing the woodwork is substantial and the plumber's work is properly done, it is practically indestructible. But in the case of soft water the solvent action not only destroys the metal, but also poisons the water. This action is seen mostly at the bottom of a lead-lined cistern, the sides being affected in a less degree. The chemical effect is that the oxygen in the water, either as one

of its constituent parts, or in a larger degree when the water is aerated, attacks the surface of the lead and produces an oxide of the metal, and if no further action takes place, as in the case of hard water, very little harm would be done. But as all water contains carbonic acid, more or less, this in turn acts upon the oxide and forms a carbonate; this is seen by the little spots of whitish-grey powder on the bottom of the cistern, and which will go on forming until the lead is eaten through.

But when the water contains mineral salts, such as carbonate and sulphate of lime, these combine with the oxide before the carbonic acid has acted, and produce a kind of protective coating, which arrests any further solvent action. In fact, so hard is this coating that it is very difficult to remove it if it should be necessary to do so. It must, however, be pointed out that some hard waters, which contain chloride of sodium and nitrates, besides the carbonate of lime, have a very rapid solvent effect upon lead; so that, although it is possible to store water in lead cisterns in many cases safely, until the character of the water is clearly determined, there is a large amount of risk about it; so much so that lead storage cisterns have for many years been going out of use, and are only likely to gain favour again in exceptional cases.

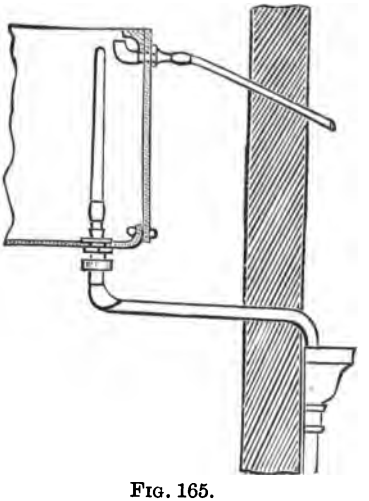


FIG. 165.

The material which seems to be taking the place of lead is galvanised iron, and although this is not above suspicion in the matter of metallic poison, it certainly withstands the action of soft water better than lead.

The sulphates and oxides of zinc are irritant poisons which act very quickly, whereas lead is said to be an insidious and cumulative poison, which will undermine a person's constitution before it reveals itself.

But whatever effect water may have on galvanised iron cisterns there does not seem to be any authentic cases of poisoning which can be traced to this cause.

One of the objections to galvanised iron cisterns is that they are not durable; in fact, some have been known to have holes eaten through them in five or six years. This no doubt is the effect of very soft water in some cases, and lead would be affected in a similar manner. But my experience indicates that it is often the result of thin plates. True, the galvanising coating is the same whether the plate is thick or thin, but there seems to be no doubt that the galvanising is much more durable on a thick iron plate than on a thin one. This may be due to the rigidity of the thick plate, whereas the thin plate will vibrate to a much greater extent, and so disturb or by some such means disintegrate the particles of the zinc coating.

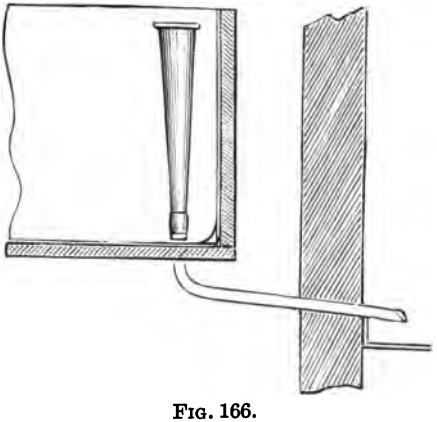


FIG. 166.

Where it is necessary to construct cisterns for the storage of water for dietetic purposes, whatever the character of the water may be, there can be no doubt that slate is one of the best materials to use. The objections which are often raised against its use are excessive weight and liability of fracture during frosty weather. But as a rule both of these objections

can be overcome, first by proper protection, such as a wooden enclosure having a cavity which should be filled with a non-conducting material like slag wool or sawdust, the former for preference. As to the weight, this is, of course, very great when large cisterns are required. But, generally, bearings can be found for iron or steel joists on which to carry the cisterns.

Another material which has been used to some extent for small storage cisterns during recent years is glazed fireclay. And so far as the material is concerned there is nothing better, but the difficulty is, it cannot be used for large cisterns which may be required for holding more than about one hundred gallons. In cases, however, where storage is required for filtered water which is only used for drinking, they can be obtained large enough for this purpose.

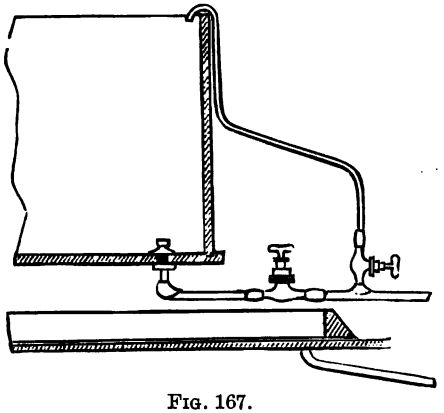


FIG. 167.

In the arrangement of storage cisterns it need not be pointed out that it is against all modern sanitary regulations to supply a water-closet direct from a cistern which contains water that is used for drinking. As a rule where wash-down water-closets are used, the flushing cisterns act as disconnectors between the storage cistern and the water-closet; but some authorities go further than that, and insist on having a separate storage cistern for supplying flushing cisterns only, quite independent of the cistern for drinking water. And where expense is no object it is no doubt a good plan to adopt, although it is somewhat

difficult to show its absolute necessity from a sanitary point of view.

All cisterns should be provided with a plug waste, and the bottom of the cistern arranged to fall slightly to the outlet. This waste pipe should be arranged to discharge into a convenient place, such as a gutter or channel, or it may be taken into the open head of a rain-water pipe if the outlet from the cistern is in the form of a plug. But this would not be permissible if it acted as an overflow also. That is to say, an open pipe in connection with a cistern

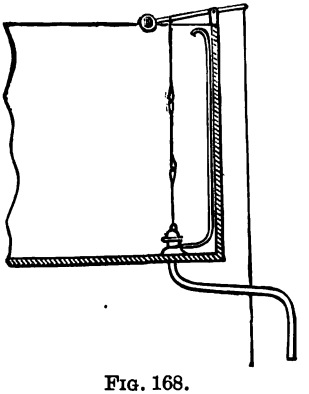


FIG. 168.

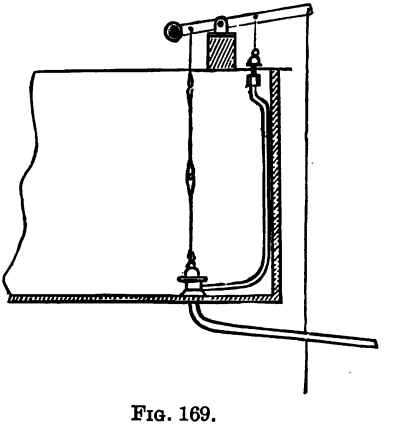


FIG. 169.

should never discharge into a pipe that may become foul, as rain-water pipes are liable to do. But if the pipe is not open in the cistern (except, of course, when the plug is removed), it cannot be objected to; then a separate overflow pipe must be fixed to act as a safety pipe, and also a warning pipe, as shown at Fig. 165.

The waste pipe can be made to act as an overflow and warning pipe, providing it discharges into the open air away from all sources of contamination, in the manner shown at Fig. 166. The service pipes should be connected to the cistern either at the bottom or the side, as far from the

waste pipe as possible, and should always be about one and a half or two inches above the bottom. This will prevent the sediment at the bottom flowing into the pipes when the cistern is being cleaned out, or at other times. It is also important that each service pipe should be fitted with a stop valve near the cistern, and in order to ensure the emptying of the pipes during frosty weather, or when repairs are required, an air pipe should be fixed near the outlet of the stop valve, as shown at Fig. 167, so that air can pass in to take the place of the water; otherwise, in many cases, the pipes will remain full of water, because they are so arranged that air cannot gain access to the pipes from the lower ends where the water is drawn off.

It is, however, found necessary in many cases to fix stop valves in the air pipes, so that they can be shut when the services are in use, and thus prevent air passing into the pipes while water is being drawn; for when air is drawn through with the water it causes a splashing and spluttering at the draw-off valves which is a nuisance.

If the air pipes are arranged in this way, all that is necessary is to shut the main valve and open the air valve when the pipes require emptying, and shut the air valve when the water is on.

Sometimes drop valves are fixed on the service pipes inside the cistern, as shown at Fig. 168, to which wires and levers are attached, so that the water can be shut off from the lower part of the house by releasing the wire instead of having to get into the roof to shut the stop valve; and where the valves are periodically attended to they are very convenient, but if they are neglected they become fixed and will not drop.

In this case the air valve can also be of the spindle form, and be made to lift when the main valve is dropped in the manner shown at Fig. 169.

CHAPTER XXXII.

BALL VALVES.

ONE of the greatest objections to storage cisterns is that they accumulate all manner of filth, for, in addition to dust, sooty matters, and spiders, dead rats and mice are sometimes found in them. But this is generally the result either of placing cisterns in improper positions or not providing them with well-made covers. All cisterns should be placed in properly constructed cistern rooms, having closely boarded floors and either boarded or plaster walls and ceilings. Generally, it seems that any out-of-the-way space in the roof is considered good enough for water storage, for whatever purpose it is used. One of the worst places is below the level of the ceiling joist under a roof where rats and mice, and even cats, can fall in as if it were a trap placed there for the purpose.

They should therefore be fixed wholly above the floor level, and provided with tight-fitting covers made of tongued and grooved boarding. In the case of large cisterns the greater part of the cover should be fixed with screws, and only that part made to open where it is necessary to give access to the ball valve and waste pipe. It is also a good plan to hinge the part which is made to open, because one very often finds the movable parts are displaced and sometimes used for other purposes. In one case the plumber had evidently fixed the cistern lid up in the roof as a bench, and had left it in that position until he was required for the next job. But if the lid is secured to its place by strong hinges

it, at any rate, is not so likely to be removed as it would be if left loose. And in replacing the lid it is sure to fall into its right place, whereas it may be safely said that 50 per cent. of the unfixed cistern lids are generally found either out of their place or improperly fitted on the cisterns.

One of the most frequent causes for badly fitted cistern lids is the careless fixing of the ball valve. The usual method is to turn the main pipe over the top of the cistern and then cut a large shapeless hole in the lid to allow the ball valve to work, thus rendering useless any care that may have been taken to make the lid to fit the cistern.

If the ball valve must be fixed above the top of the cistern the lid should be raised at that end by a curb, as shown at Fig. 170, in order to avoid the hole in the lid.

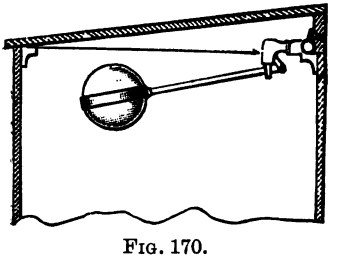


Fig. 170.

But the best plan is to fix the ball valve below the top of the cistern, either by bending the main pipe down, as it can be in the case of a lead cistern, and fixing the ball valve just below the top, as shown at Fig. 171A, or by passing the pipe or boss through the side of the cistern, making it good by a flange joint, as shown at Fig. 171B. By this method the hole is cut fairly large, the inside edge rounded, and the end of the pipe passed through and opened large enough to receive the brass boss. The edge of the pipe is then tafted back in the form of a bead, and shaved in the ordinary way for a flange joint, a section of which is shown at Fig. 172. By this method the boss is soldered to the pipe and a secure fixing obtained by the one joint.

In the case of a galvanised-iron cistern a hole should be cut below the angle bar just large enough for the thread of the ball valve to pass through; the boss is then

placed in position and the ball valve screwed in, a washer being placed each side of the cistern, as shown at Fig. 173. This also makes a very secure fixing, and allows the lid to fit properly.

A similar arrangement can be carried out in a slate cistern, but it is necessary to have the thread of the ball valve longer than usual owing to the thickness of the slate.

In some instances the ball valves are fitted with long threads, and also with fly nuts and unions, one of which is shown at Fig. 174, in connection with a slate cistern. The same fitting can be used for an iron cistern, instead of that shown at Fig. 172.

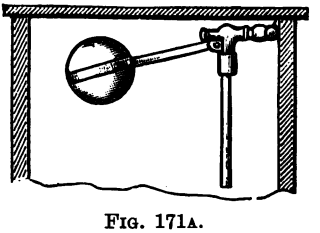


FIG. 171A.

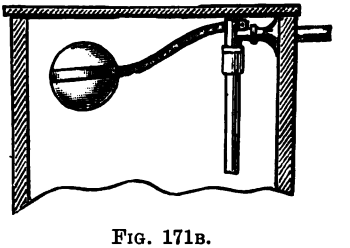


FIG. 171B.

It may be well to point out that one of the most frequent causes of the noises, vibrations and other nuisances which arise from the ball valves in common use is owing to improper fixing. One often finds the main pipe taken straight over the side of the cistern, with the ball valve projecting six or eight inches from the side without any attempt at fixing, with the result that the buoyancy of the ball is sufficient to move the valve every time it rises, and thus render it a constant source of nuisance, either by the necessity of repeated adjusting, or vibration and the consequent rattling noises which are often alarming to nervous persons who do not know the cause of them. In many cases the noises are attributed to the hot-water pipes or the boiler, whereas

they are then raised by a cheap and badly arranged ball valve.

As ball valves are often a source of great nuisance, both in storage cisterns and in flushing cisterns, a brief description of some of those most commonly used may be instructive and interesting.

There can be no doubt that the ball valve most extensively used is that known as the "Croydon". But this cannot be on account of its superior qualities; its simple construction and consequent cheapness may probably have more to do with its favourable reception.

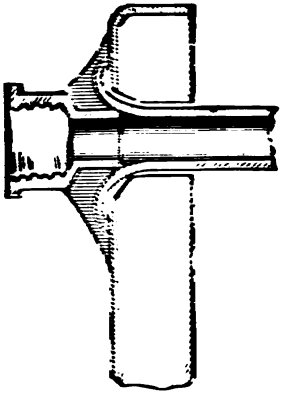


FIG. 174.

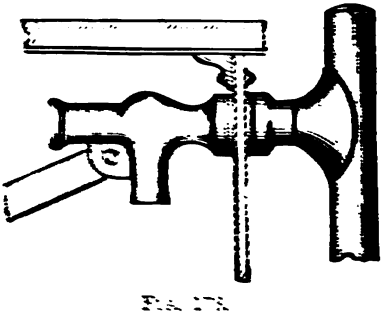


FIG. 175.

When the intermittent supply of water from the main was more general than it is now, it was necessary to use ball valves which possessed a full water way through them, so that the cistern in which they were fixed could be filled in a short time. But in order to get a full-way valve, it was necessary to adopt what is known as the equilibrium principle, or some form of compound levers, which rendered the construction more complicated and expensive.

With the introduction of the constant-supply system, however, the full-way ball valves were not often required,

or, at any rate, were not absolutely necessary, because the water being always on at the main, the cisterns could fill up more slowly than under the intermittent system.

It was found, therefore, that by reducing the orifice on the valve seating of a ball valve the force of the pressure of water was reduced in the same proportion, and by that means the equilibrium principle could be dispensed with, the valve simplified, and the cost reduced considerably.

But like many other things of a similar kind, in the effort to cheapen the articles some manufacturers went to the very extreme and turned out ball valves by the gross, which were not only cheap, but nasty, and more nuisance than they were worth. And as the "Croydon" valve is the simplest in construction, it seems to have suffered most. Although there can be no doubt that if a "Croydon" ball valve is well made, so far as wear and tear and durability are concerned, it is hard to beat. But when the question of noise and vibration is considered, this form of valve leaves much to be desired. As a full-way ball valve is often necessary where a cistern is supplied with water at a low pressure, it will be well to describe the equilibrium form first.

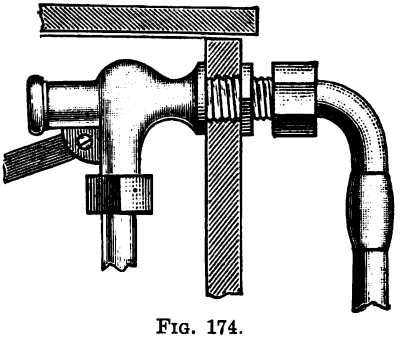


FIG. 174.

Fig. 175 shows a section of one of the most common forms of full-way ball valves constructed on the equilibrium principle. The meaning of the term as applied to a valve of this kind is that there is a state of equilibrium set up by the pressure of water being made to exert as much force towards the closing of the valve as it does in opening it.

As water pressure exerts itself equally in all directions,

when the valve is closed the pressure upwards on the cup leather in the cylindrical part of the valve is exactly the same as that exerted on the valve seating in a downward direction.

Consequently there is a state of equilibrium set up between the upward and downward pressure inside the valve. So that, theoretically, if the arm of the ball is removed the valve should not open under any amount of pressure, as the power which tends to open it also tends to keep it closed in the same degree. It follows, therefore, that in a well-constructed ball valve of this kind the buoyancy of the ball and the length of arm attached to the ball does not actually shut off the water, but only overcomes the friction between the cup leather and the sides of the cylinder in which it works. On this account the amount of pressure does not materially affect the size of the ball or the length of the arm, excepting that the greater the pressure the more friction there is on the cup leather.

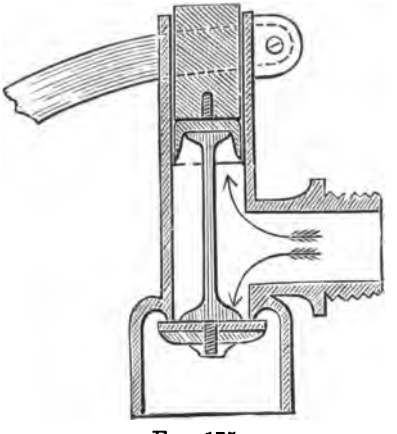


FIG. 175.

Now, in the absence of the equilibrium principle, the shutting of the valve depends wholly on the power produced by the buoyancy of the ball and the length of the arm which forms a lever. This can be seen by referring to the section of a "Croydon" ball valve shown at Fig. 176. As there is nothing but this leverage to depend upon, it is necessary, in order to use an arm of ordinary length and a ball of a usual size, to reduce the size of the orifice on the valve

seating, and thus reduce the power of the pressure. Usually there are three forms of valve of the same specified size which are suitable for high, medium and low pressures, but in each case the way through the valve is considerably smaller than the size specified. For instance, a three-quarter inch ball valve for high pressure would not have more than about a quarter-inch orifice, and for a low pressure the orifice would be about half an inch. So that the specified size of valves of this kind is somewhat misleading, and often causes a great waste of materials. One would ask, for example, what use it is to fix a three-quarter inch rising main to a ball valve having only a quarter-inch way through it, the difference in the bores being as one is to nine.

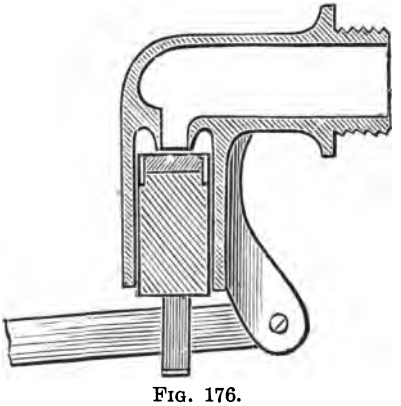


FIG. 176.

There is, of course, some advantage, because the large size of the pipe reduces the resistance due to the friction of the water passing through it. But the difference need not be nearly so great on this account. What it amounts to so far as the ball valve is concerned is that, given a pressure of, say, 60 lb. per square inch in the water companies' main, the pressure on a three-quarter inch circle would amount to 26·5 lb.; this represents the pressure on the valve seating of an equilibrium ball valve. But in the case of Fig. 176, where the orifice is only a quarter-inch diameter, the pressure to be resisted by the power of the ball and arm is only a ninth of 26·5, or 2·94 lb. or 3 lb. nearly. This result is obtained as follows: If the pressure on a square inch is 60 lb., as ·7854 is the proportion which a

circle bears to a square, then 60 × ·7854 = 47·124 = the pressure on a circular inch. And as the areas of circles are to one another as the squares of their diameters, if an inch circle is taken as 1 the three-quarter inch circle is ·75 × ·75 = ·5625, or a little more than half the area of a one-inch circle. Now if the pressure on a one-inch circle is multiplied by this fraction, thus 47·124 × ·5625 = 26·5 = pressure on three-quarters of a circle, and as a quarter circle is a ninth of a three-quarter circle, by dividing 26·5 by 9 (26·5 ÷ 9 = 2·94) we find that 3 lb. of pressure nearly is the amount of power which the buoyancy of the wall and the leverage of the arm has to resist. This goes to show that if a Croydon ball valve had a full way it would be necessary to enlarge the ball and lengthen the arm sufficiently to exert at least nine times as much power as that necessary for an equilibrium.

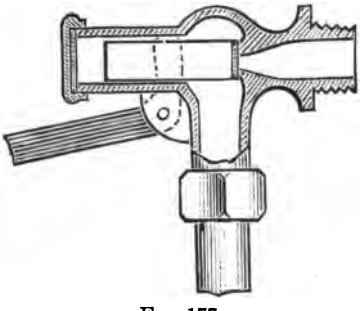


FIG. 177.

One of the most frequent causes of vibration which produces the humming and chattering noises so often complained of in connection with ball valves, besides the noise of running water while flushing and other cisterns are filling, is owing to the absence of a silence pipe on the outlet of the ball valve. And in the case of the "Croydon" (Fig. 176) ball valve it is impossible to fix a silence pipe to the outlet, because the end of the piston and lever is in the way; and although an attempt is sometimes made to attach a silence pipe it is always a bungling sort of a job.

It is generally noticed that this form of ball valve is more than usually noisy; the reason is, no doubt, due to its construction, more especially on account of the issuing water

being divided into two streams, and flowing out on each side of the piston.

My own experience is that when a high-pressure ball valve is required one of the kind shown at Fig. 177 is the most satisfactory to use, for they not only are less noisy, but a silence pipe can be attached without any difficulty either by a socket joint on the nose or by having a cap and lining connection, as shown in the sketch.

It will be noticed, however, that the principle of the ball valve is similar to the "Croydon," with the difference that

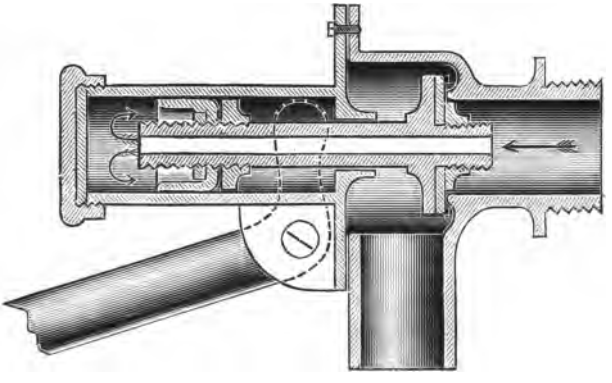


FIG. 178.

the piston works horizontally instead of vertically. The seating is therefore vertical, and this has a decided advantage over the other style, because grit or pieces of other solid matter are not so likely to remain on the rubber seating and cause leakage.

The reduction of the size of the orifice on the valve seating is similar in every respect to the "Croydon," and from a mechanical point of view it works on the same principle, with the exception that the lever on the "Croydon" is of the second order; but the lever at Fig. 177 is of the first order. But this does not alter the mechanical value of

the leverage, so that if the pressure of the water per square inch in the main is the same as that given in the former example, and the size of the orifice is the same, the dimensions of the ball and lever would be required to be about the same.

If a full-way ball valve of a similar shape to the above high-pressure valve is required, that shown at Fig. 178 is the best to use. This, like the last full-way valve shown at Fig. 175, is constructed on the equilibrium principle, but the application is somewhat different. It will be seen in the section that the piston is formed by a hollow tube, which conveys the water under pressure to a hollow space in the end of the cylinder. The space is closed water-tight at the end by a screwed cap fitted with a leather washer. There

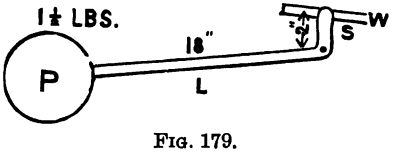


FIG. 179.

is also a cup leather on the end of the piston which closes the other end of the hollow space, but allows the piston to move to and fro by aid of the ball and lever, the latter having a two-pronged end fitted in a sinking each side of the piston.

Now, as water pressure exerts its power equally in all directions, and as the size of the tube which conveys it from one part to another does not affect its force, it will be seen that the water which passes through the centre of the piston to the front of the cup leather will exert exactly the same force on the piston at one end as it does on the valve seating at the other, the areas of which are both equal.

The function of the buoyancy of the ball and the power of the lever is, as in the former case of the equilibrium valve, to merely overcome the friction of the cup leather in the

cylinder, for the pressure of the water is utilised for actually shutting off the valve. With regard to the mechanical value of the ball and lever, this can be calculated by first finding the buoyancy of the ball, which can be called the power; this is multiplied by the length of the long end of the lever, and the product divided by the length of the short end of the lever.

The buoyancy of the ball is equal to the weight of the water it displaces, so that if the ball is half submerged, then the weight of the water which is contained in half a sphere equal to the size of the ball is easily found by well-known rules of mensuration. If we assume that this amounts to 1½lb., and lengths of the ends of the levers, as shown at Fig. 179, and P to represent the weight, S the short end of the lever, and L the long end, then W will represent the power exerted. The formula for working it out is $W = \frac{P \times L}{S}$, or if the P, W and S are known the length of the lever required is found by the formula $L = \frac{W \times S,}{P}$ or if W, L and S are known, the power or buoyancy is found thus: $P = \frac{W \times L}{S}$. According to the first formula, the weight exerted on the valve seating is shown thus: $\frac{1{\cdot}5 \times 18}{2} =$ 13·5 lb.

CHAPTER XXXIII.

TOWN HOUSE SANITARY ARRANGEMENTS.

HAVING described most of the arrangements required in a suburban house, where the drains are situated outside the external walls, and where stoneware drains are generally considered to be substantial enough for their purpose, it may be well now to give an example or two of the drainage and general arrangements required in a town house, where the drains must necessarily pass under the building.

Under such circumstances, most authorities in the present day are agreed that the drains should be of such a character that the water test can be periodically applied with the reasonable expectation that they may be found water-tight so long as the materials of which they are constructed remain intact, and are not seriously deteriorated by the variation of temperature and chemical influences.

And although there is still a considerable amount of prejudice against cast iron as a material for drains, on account of its oxidising tendencies, as compared with salt-glazed stoneware pipes, the fact remains that, however carefully a stoneware drain is laid and jointed, it cannot be guaranteed to remain absolutely water-tight for any length of time. The contention that glazed stoneware is practically indestructible is no doubt right as far as the material of which the pipes are made is concerned, but the difficulty is with the joints; and, notwithstanding the numerous inventions during recent years for the purpose of making the joints more secure, experience proves that, although some

stoneware drains are found to remain sound for many years, many others, which are constructed under the very same conditions, will not hold water for very many months after they are covered in. The leakage may not be serious, and in most cases, where the drain is well laid, perhaps quite harmless; but while a drain is not sound, especially when it passes under a dwelling-house, it cannot be regarded as satisfactory; and as it is difficult to find out the character of the defect, slight as it may be, there is always the possibility of it becoming worse, and therefore dangerous. On the other hand, it must be admitted, as the writer has found on more than one occasion, that it is possible for a defect in a stoneware drain to heal up, as it were. That is to say, that a slight leakage may be found to exist soon after the drains have been constructed, but on applying the water test again, say, a year after, the leakage is found to be less; and on again testing the drain after another interval, they are found quite water-tight. The probability is that the cause of the leakage, in the first place, was owing to porous, or what are sometimes called sweating joints; and as this defect generally occurs at the bottom of the joint, after a time the solid matters in the sewage fill up the interstices in the joint, and ultimately it becomes sound. This must, however, be regarded as exceptional, for it is well known that when a joint is broken, or some other structural defect exists, the leakage is more likely to get worse than better.

It is, therefore, important that a material should be used for drain pipes which is not likely to be affected by a slight subsidence of the ground, or by a rapid change of temperature, which many drains are subjected to, on account of the very hot water which is discharged into them, besides the waste steam which is frequently blown through the soil drains, the latter being the cause of the failure of many stoneware drains, as it cracks them in all directions.

By the use of heavy cast-iron pipes these difficulties can be overcome, and the surface of the metal can be preserved by a bituminous solution generally known as Dr. Angus Smith's. They are also protected by glass and porcelain lining, which has the further advantage of giving a much smoother surface to the inside of the pipe. So far, however, the glass-lined pipes have not been used very extensively, as experience has proved that the bituminous solution has answered the purpose very well. My own experience of iron drains dates back for more than twenty-five years, and after periodically testing and examining these drains during that time, they have been found to be practically unaffected by the action of the sewage, and no material deterioration has been apparent. Among the several other advantages they possess, as compared with stoneware, nine-foot lengths can be used, and thus reduce the number of joints, because it must be remembered that the joint inside a drain always offers a certain amount of obstruction to the flow of sewage, more or less according to the way the drain is constructed, so that the fewer the joints the better the flow of sewage, and the cleaner the drain. A longer bearing is also obtained for the pipes in long lengths, making the drain secure against disturbance by slight movements in the ground, and other causes. The joints, when properly caulked with metallic lead, are as rigid as the pipes, and except under unusual circumstances, which will be mentioned, are quite reliable.

In the drain plan shown at Fig. 180 it will be seen that only that part of the drains which passes under the house is iron, the remainder being stoneware. This is a style which has been adopted very generally during the last few years, probably as a sort of compromise to those who prefer glazed stoneware pipes, but who recognise the liability of these to fail when the water test is periodically applied, and so are

content to have iron drains under the house, where a leakage would be considered dangerous. Fig. 181 shows the lines of the drains when they were defective. This plan is produced in one of the early chapters.

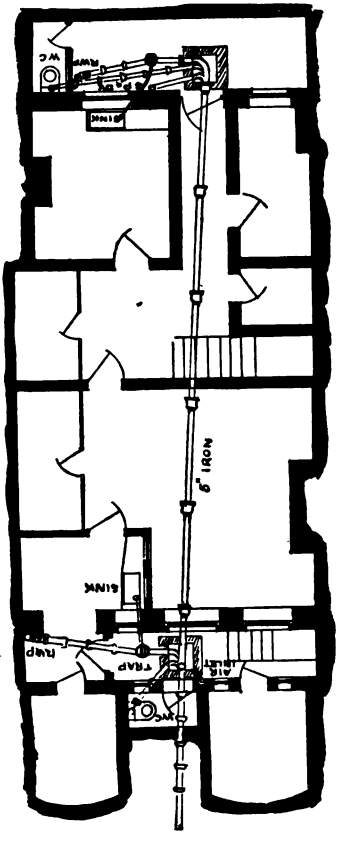


FIG. 180.

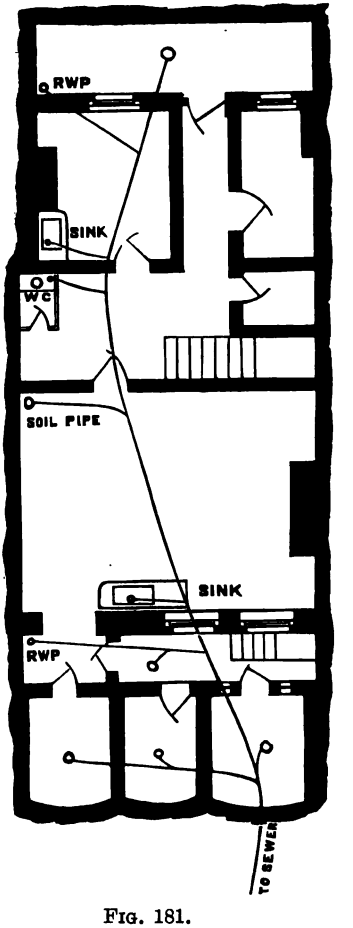


FIG. 181.

It will be observed from the plans shown in Fig. 180 that in order to arrange the drains and fittings in a satisfactory manner it was necessary to alter the position of

those in the basement in such a way as to need structural alterations.

The position of the water-closet, for instance, on the old plan, Fig. 181, was in every way objectionable. It was not situated against an external wall, and was, therefore, not lighted or ventilated direct from the open air, as is required by modern sanitary regulations; and as it opened into a lobby at the foot of the stairs, the effluvia which often passed up the staircase can be well imagined.

And this is no isolated case; for although thousands have been altered during recent years, there are still existing water-closets in similar and even worse positions in numerous instances. As will be seen from the new plan, the space occupied by the centre vault in the front area has been made use of for a new water-closet in accordance with the London County Council bye-laws, which require that a water-closet shall have one external wall, and where it is constructed below the surface of the ground it must be approached directly from an area or other open space available for purposes of ventilation, measuring at least forty super. feet in extent, and having a distance across of not less than five feet, and not covered in otherwise than by a grating or railings. It is also necessary to provide a window of an area of not less than two square feet, which shall open directly to the open air. In addition to such window, at least one air brick or shaft has to be fixed to an opening through the external wall in order to provide constant ventilation in the water-closet apartment.

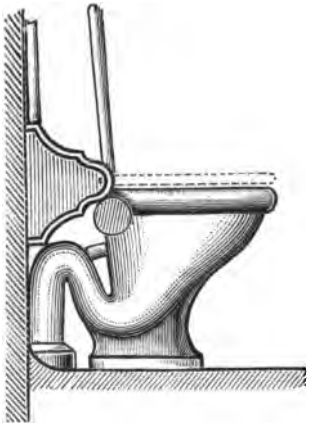


FIG. 182.

In the back area an additional water-closet is provided for menservants' use under the same conditions as those for the front area. The floors of these water-closet apartments should be made of some impervious material, such as trowelled cement, tiles, or asphalt, and laid with a fall of about two inches towards the door, in order to prevent any splashing or overflows remaining around the water-closet. A further improvement is to form all the angles in the apartment to a curve of about a three-inch radius; and if the walls are tiled, angle tiles can be obtained of this description. By such an arrangement it is a much simpler matter to thoroughly clean out every part of the apartment. With regard to the form of closet, nothing is more suitable than a simple wash-down pedestal, having a lifting seat and syphon-action flushing cistern. Where such closets are likely to be affected by frost or subjected to rough treatment, they should be made of fireclay instead of the ordinary whiteware. The fireclay fittings can be obtained either white glazed inside and out or white inside and brown or cane outside. In the case of the men's water-closet, if it is likely to be used very frequently as a urinal, a balance-action seat is often desirable; this form of water-closet is shown at Fig. 182. There are various ways of arranging the automatic lifting of the seat either by springs or weights, but the latter, as a rule, is the most simple and least likely to get out of order. It merely consists of a lever on one or both sides of the seat, as shown in the sketch, to which is attached a weight of sufficient power to raise the seat easily

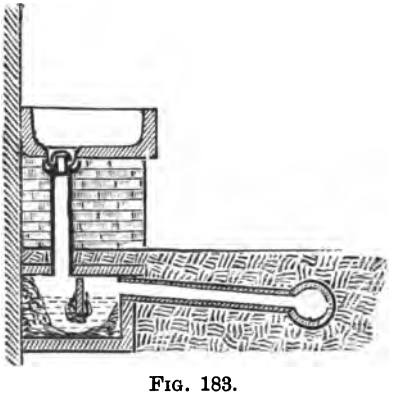


FIG. 183.

and not too quickly. The result of this arrangement is, that instead of the seat being continually saturated with urine, through persons neglecting to raise the seat when they should, it is always up against the wall, except when it is necessary to place it down on the water-closet.

The pantry sink in the old plan is shown in a dark corner, which is an unsuitable position either for one working at the sink or for disposing of the waste pipe from it. The original arrangement of the waste pipe is shown at Fig. 183. In the days when this was done there were no scruples about disconnection and ventilation. A trap of some kind was considered necessary so long as it possessed a water seal, and then the nearest run to the drain was the only object in view.

In this case, however, it is probable that only after the effluvia from the cesspool trap under the floor found their way through the grating in the sink, a bell trap was added to the outlet of the sink. But as this had a loose bell and grating it was continually removed for the purpose of removing the sediment which repeatedly caused a stoppage, and thus allowed the foul gases from the cesspool trap to escape into the pantry.

In the new plan the sink is placed under the window and against the external wall where it could be treated in the manner shown at Fig. 184. In this case a tinned copper-lined deal sink is fixed 2 feet 6 inches × 1 foot 10 inches × 1 foot 0 inches deep on iron cantilevers fixed in the wall, so that the space under the sink is quite clear of legs or piers. The waste outlet is fitted with a three-inch plug and washer, and connected to a two-inch trap with a cone inlet and a two-inch ventilated waste pipe discharging into the side of a self-cleansing intercepting or gully trap in the area. This gully also receives the branch drain from a rain-water pipe and the surface water from the area. The gully is therefore kept

charged with water by the sink waste during dry weather, thus avoiding the escape of drain air which often occurs when rain and surface water are drained into a separate gully.

On referring again to the plans at Figs. 180 and 181 it will be seen that in the old arrangement no separate apartment was provided for the scullery, the only sink in this part of the basement being situated in the kitchen; and although it is very usual to have a sink in the kitchen, it is nevertheless important that the sinks or sink for scullery work should be placed in a separate apartment. In the present case a

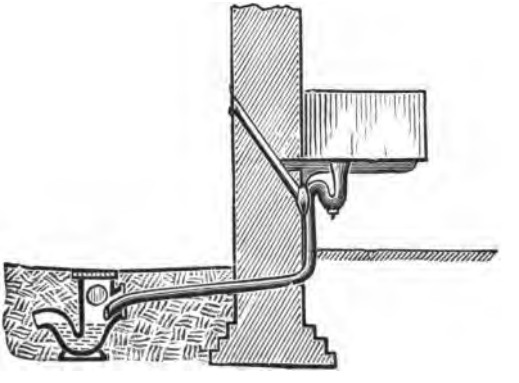


FIG. 184.

small part of the kitchen is therefore partitioned off for this purpose, having a new window opening to the area and the new sink fixed as near as possible to the light. As this is only a small house, and the space being limited, only one sink is fixed; in a larger mansion a set of three or four sinks is necessary for convenience and cleanliness, but the description of these must be left for the present. The most suitable sink in this case is one of white glazed fireclay about 48 inches × 24 inches × 8 inches outside dimensions, fixed on cantilevers securely pinned into the wall, or, if the wall is not substantial enough, galvanised brackets should be used, and in no case

should the old style of brick piers be used for supporting the sink. The waste grating should be as large as practicable, and not less than three inches diameter; the two-inch trap should have a coned inlet, and the waste can be treated in the manner shown at Fig. 185, and arranged to discharge below the grating of a self-cleansing gully trap, similar to that shown for the pantry sink. It should be pointed out that although it is desirable to ventilate all waste pipes, syphonage is not very likely to take place in a trap connected to a sink of this kind, because the last portion of the water

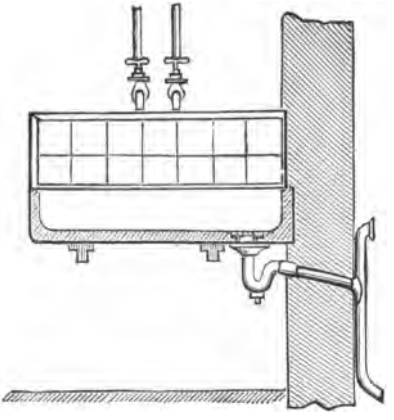


FIG. 185.

discharged into the sink always drains away slowly, and does not disturb the water seal in the trap. All sinks of this kind should be finished with two or three courses of white glazed tiles where they join back or side walls, and the face of the tiles should always be fixed flush with the inside of the sink in the manner shown in the sketch. A good finish is obtained by fixing a hardwood capping to the top and side edges of the tiles as shown. Some people regard the addition of tiles as extravagant, but it is not only cleanly and of good appearance, it really adds but little to

the cost, and it is certainly more durable than lead flashings. Besides, lead flashings, in my opinion, are entirely out of place on white glazed sinks. The only other important alteration which affects the drain pipe is that the soil pipe being placed outside the external wall, the connection to the drain is outside the house, and in a position where it can effectually ventilate the drain from the highest point.

CHAPTER XXXIV.

DRAINAGE.

WITH regard to the details of the drainage, the first thing necessary is a new connection to the sewer in order to get the main drain in a straight line, and to ensure the whole being in good order. This is an important point, because, as a rule, the drain under the public road between the house and the sewer, which is laid by the local sanitary authority, is the worst laid portion of the drain. Probably the men who lay them consider that the soundness of this portion is unimportant, but they used to carry this idea to such an extent that the pipes were often thrown in, no attempt being made to provide a good concrete foundation, with the result that when the trench was opened deeper than necessary loose earth was put under the pipes, and when the upper part of the trench was filled in the drain became dislocated and in such a form as to cause frequent stoppages at this point. So that when the house is redrained it is well to make sure of the connection to the sewer.

In many cases an access pipe like Fig. 186 is fixed in the drain as near the boundary wall of the premises as possible, for the purpose of inserting a testing stopper with the object of testing with water the portion of drain beyond the disconnecting chamber. In the absence of such a fitting this portion of the drain cannot be tested. And where it is considered advisable to test the whole of the drain within the walls periodically, a manhole should be built over the access pipe; but this is not often done,

because, for one reason, it would be regarded as a source of weakness on account of its being on the sewer side of the disconnecting trap, and from the probability of the cover being left unsound. We come now to the disconnecting chamber: this should be constructed of nine-inch brickwork in cement, and rendered inside with cement and trowelled to a smooth face. The longitudinal section showing the intercepting trap is shown at Fig. 187. The principal feature of the trap is that it should have a fall of about three inches from the inlet to the water line in order to provide as much as possible a self-cleansing action. The water seal should not be less than three inches deep, and it should be provided with an access arm connected to the outlet of the trap

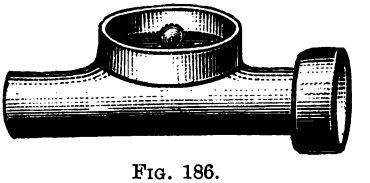


FIG. 186.

so that the drain beyond the trap can be inspected or cleared when necessary.

With regard to the names of the traps which are generally fixed in manholes, there is considerable uncertainty as to whether they should be described as interceptors or disconnecting traps. From my point of view the proper name of this form of trap depends upon the manner in which it is arranged and fixed. Any form of trap in whatever way it is arranged may be described as an interceptor. The old style of running trap, for instance, which was merely a trap and nothing more, may be said to have intercepted a drain, and any modern form of trap arranged in the same way, without access or an air break, would be nothing more than an interceptor. But when a trap is fixed in connection with an access manhole and a fresh-air inlet, it not only

intercepts the drain, but it also disconnects it by an air break between the water seal and the house drain.

The more complete the form of air break, the more effectual is the disconnection carried out.

In the case of a town house of the kind we are considering, the air break is not so complete as one would like to see, as it is generally necessary either to fix a mica inlet valve on the end of a long length of pipe leading to the manhole, or, in the absence of a valve, to continue the air inlet pipe a much greater distance where the occasional escape of foul air would be rendered harmless.

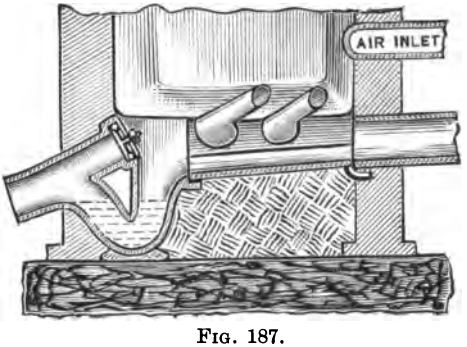


FIG. 187.

All this tends to restrict the amount of fresh air passing into the manhole and drains, but still the principle is carried out to as great a degree as is desirable under the circumstances of the case.

The most complete method is of course that adopted for the disconnection of sink and other waste pipes, where the end of the pipe actually discharges into the open air above the water of the gully trap. This, so far as house drains are concerned, is generally impracticable, although at a country house, where the disconnecting trap can be fixed a considerable distance from the house in an open meadow, the disconnection can be as effectual as that of a sink waste.

The "disconnecting trap," then, seems the proper name if it is fixed as it should be, in connection with the air break.

During recent years there has been a considerable outcry against the low level fresh air inlet, open gratings cannot be tolerated, and mica valves are unreliable; the only plan, therefore, according to many persons, is to take the air inlet pipe up the front of the house well above windows, where it in most cases must be terminated at nearly the same level as the soil pipe ventilator. In some cases the ventilating pipe to the front manhole is continued to the highest point in order to act as an upcast, while the soil pipe is kept as low as practicable and made the downcast or air inlet to the drains as shown at Fig. 188. Where such a plan is necessary, the latter method is undoubtedly the best. But so far as my own experience is concerned, the difficulty can generally be overcome without the necessity of raising the air inlet to an unusual height. For the fault in most cases, as already pointed out in a previous chapter, is to be found in the improper termination of the upcast ventilating pipe, where a down draught is encouraged. But where the pipe can get a clear blow straight across the top, a fairly constant up draught can be depended upon, excepting when a discharge is passing down the soil pipe; a good form of mica valve is, however, quite effectual in preventing the

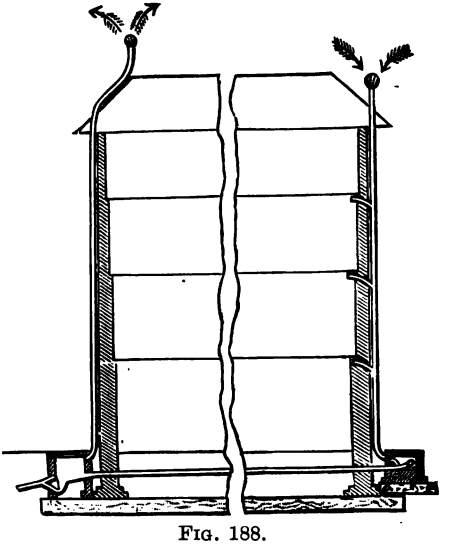


FIG. 188.

escape of foul air for the moment. And when the air break disconnection is kept in mind, it is obvious that the less the resistance is to the passage of the fresh air to the disconnecting chamber the better. From my own observation of the high level air inlet system, except where some special means are used to induce a constant movement of the air in the pipes, where the inlet and out pipes are nearly the same level, the movement of air is so slow as to reduce the ventilation to a mere theory, and to render the fresh air break non-existent. One is aware that in some instances it is advisable to provide an additional outlet pipe on a small

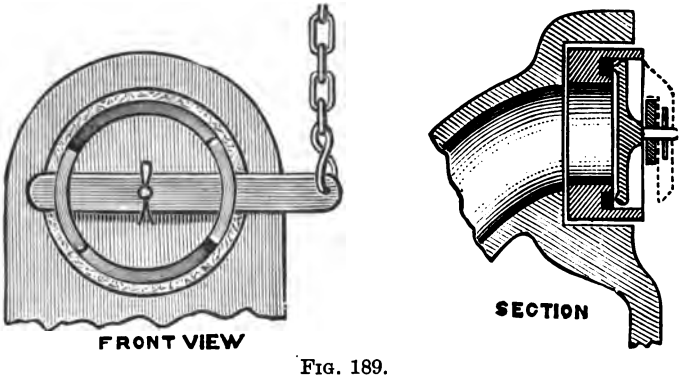


FIG. 189.

system of drains, where the discharges down the soil pipe cause a compression of air in the drains and the blowing out of the water in the lower traps; but even then the low level air inlet is necessary to ensure a good flow of air through the system while the fittings are not being used. Coming back again to the disconnecting trap, it may be well to point out that the stopper in the cleansing eye is rather an important feature. It is important, if the trap is to be efficient, that the stopper should remain intact; in many instances it may be found apparently blown out of its place into the inlet of the trap, which it has stopped up and made useless. Care should be taken, therefore, to see that the

stopper has some means for securely fastening it in its place. That shown at Fig. 187 is an expanding stopper similar to those used for applying the water test to drains. The stopper shown at Fig. 189 answers two purposes—it is quite secure when fixed, and it can easily be removed in the event of the trap being stopped up and the manhole full of sewage, which can flow through the cleansing eye to the sewer and thus render the trap accessible. The stopper consists of a brass disc, which fits into a socket of the same material on a rubber or leather seating. On the centre of the disc is pivoted a lever the ends of which slide into tapered slots arranged in such a way as to cause the stopper to press firmly on the seating. No air pressure from the drain can move the stopper, nor is it likely to be disturbed from inside the manhole, but when the chain, which is attached to the lever, is pulled, the disc is raised from the seating and is easily lifted out of its place.

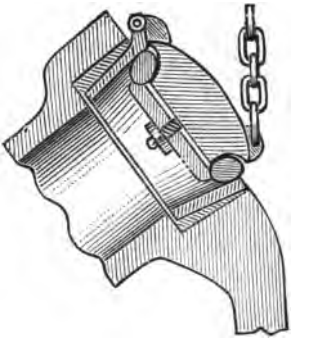


FIG. 190.

Fig. 190 is another form of stopper which is a great improvement on that in general use. This takes the form of a hinged weighted valve having a rubber seating in a tapered socket. By pulling the chain attached, the valve is lifted and the sewage in the manhole is released, supposing, of course, that the stoppage is in the trap and not in the drain beyond.

CHAPTER XXXV.

JOINTING PIPES.

AS it has become the custom to periodically apply the water test to drains, more especially those which pass under a dwelling house, as in the case of a town house of the kind we have been considering, any means which facilitate the application of the test in a convenient manner must be regarded as an advance in meeting the requirements of modern sanitation. Fig. 191 is a disconnecting trap which is fitted with a water-tight stopper having a rubber seating adjusted to the inlet side of the trap.

When the water test is to be applied, the stopper is removed from the hook or the side of the manhole, and dropped into the mouth of the trap, where it readily finds its seating. One advantage of this arrangement is that the drains can be filled and flushed out frequently without the necessity of a man getting into the manhole to insert or remove the stopper. In the absence of an automatic flushing tank, such a means for flushing the drains is of considerable importance. It is not generally recognised that completely filling the drains, even with the ordinary waste water from the various fittings, has a much more effectual cleansing effect than many of the flushing tanks now in use; because, by completely filling them up and discharging the contents rapidly, the whole of the surfaces of the drains, both main and branches, and manholes are washed, whereas many of the flushing tanks only discharge their contents quick enough to about half fill the drain, and then only the

main drain is flushed, while the branches are unaffected. One very often observes when occasionally and periodically testing drains with water, that when the water is released, large quantities of sediment of various kinds are carried away from parts of the drain where the water from the flushing tank has not touched.

Having decided upon an efficient disconnecting trap, the next thing to consider is a reliable method of constructing the stoneware drains. Although what may be called the modern system of laying stoneware drains has been in vogue

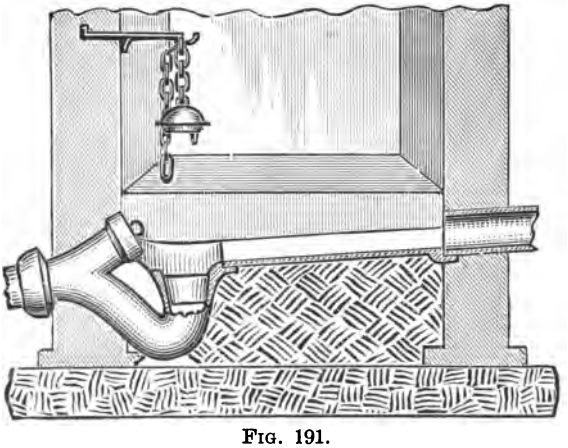


FIG. 191.

for many years, there is still a considerable difference of opinion as to the best method to adopt. The old-fashioned style of laying one pipe at a time and bedding the spigot into the socket and raking out the surplus cement from inside the pipe, is still carried out by some bricklayers and pipelayers. But where the drains have to be tested with water, much greater care has to be taken than was the case before the new systems were introduced.

The fact, however, often lost sight of is that drains are not only required to hold water at the time they are laid,

but should be sound for a reasonable length of time; and while it is perfectly true, as already pointed out, that stoneware drains cannot at best be relied upon to the same extent as those constructed of cast iron, there can be no doubt in the minds of those whose duty it is to periodically test drains with water that the mere fact of a drain being watertight at the time it is laid is but very little proof that it will remain so, even to such an extent as to answer its purpose after the lapse of a year or two.

My contention is that a very large number of stoneware drains are not unsound so much on account of the unreliability of the materials used, as they are in consequence of the improper system used in their construction. There are numerous instances where drains which are quite watertight the day after the joints are made, are found to leak badly within a week after the ground has been filled in above them. The first important thing, therefore, is that the drain should be laid on a solid bottom. This refers, in the first place, to the bottom of the trench itself, for if this is loose made-up ground it must not be supposed that six inches of concrete is going to prevent the drain from sinking, especially if there is five or six feet of earth above it. In such cases iron drains should be used, and special means used to prevent subsidence, which will have to be considered later on where such precautions are likely to be necessary.

But in the case we have in hand, at a town house, it is not very likely to occur, for in most instances a good concrete bed is all that is required, thickness of which depends on the character of the soil. If it is firm sand or gravel, only a very thin bed of concrete is necessary, providing the bottom of the trench is excavated with care and a regular surface prepared. But if the soil is soft clay or loamy mould, then at least six inches of Portland cement concrete is imperative. The surface of the concrete should be laid to a straight line to the

fall decided upon, and before it is set sinkings should be made where each of the sockets rests, as shown at Fig. 63, so that the bottom of the pipes lies solid on the concrete bed, and thus enables the spigots to be concentric with the sockets. Another method of preparing pipes for jointing is to first lay a thin bed of concrete to the necessary fall, and stand the pipes on bricks on edge, as shown at Fig. 64. By both of these methods there is no difficulty in getting the trowel all round the joints, as is necessary in order to make a reliable joint. It should be pointed out, however, that it is not necessary to make all the joints in the trench. The best plan as already explained is to put the pipes together in twos, or even threes, by standing them upright and making the joints while they are in a

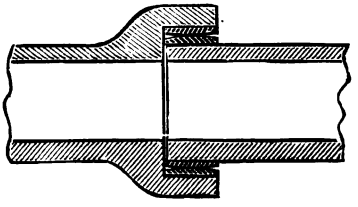


FIG. 192.

vertical position. This should, of course, be done a day or two before they are required, so that the joints can get thoroughly set. It is then only necessary to make every second or third joint in the trench.

A very important precaution to take is to chip the insides of the sockets and the outsides of the spigots before they are put together; this enables the cement to adhere much more firmly to the stoneware and renders the joint more permanent.

There are various methods employed for jointing stoneware drain pipes, but notwithstanding the numerous forms of joints which have come within my experience, nothing has, from my point of view, superseded a well-made ordinary form of socket with a joint made with neat Portland cement.

There are, of course, exceptional cases where the adjustable form of joint, for instance, as shown at Fig. 192, having a bituminous lining to the socket and covering on the spigot, is formed in such a way as to make a water-tight joint by the aid of a little resinous solution which is painted on the surfaces of the spigot and socket. These joints are more especially useful in cases where drains have to be laid in trenches where streams of water are continually running, and would probably wash out the cement joints before they are set. But it must not be supposed that cement joints can even then be dispensed with, for in many instances it is necessary to point some of the joints up with cement in order to make them sound enough to stand the water test.

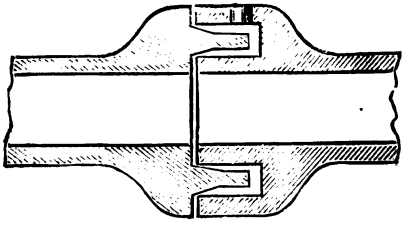


FIG. 193.

It is sometimes necessary to make use of a simple joint on account of the difficulty in finding any one skilled enough to make the ordinary cement joints, and for the purpose of overcoming this difficulty a joint of the kind shown at Fig. 193 is often made use of. This consists of a large socket having a kind of groove and tongue into which liquid cement is poured through a hole in the top of the socket. Clay is first used on the edges of the socket in order to prevent the cement finding its way into the pipe.

A similar form of socket is sometimes used in connection with a kind of asphalt cement which is poured into the groove in a molten state.

While admitting the usefulness of several of these joints

in exceptional cases, under ordinary conditions the plain socket is the best to adopt.

There is, however, one very good improvement in the form of the socket which deserves attention. It consists, as shown at Fig. 194, of an additional inner socket into which the end of the spigot is made to fit exactly, and by that means effectually fixes the spigot concentric with the socket, and thus avoids the evil which often exists in badly laid drains of the spigot lying close down on the socket, as shown at Fig. 195, and forming an obstruction at every joint in the drain, besides

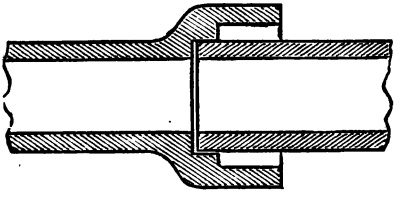


FIG. 194.

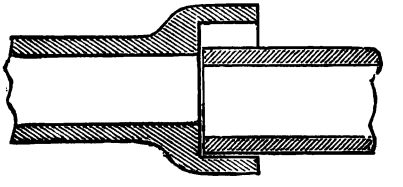


FIG. 195.

leaving little if any space at the bottom for the cement to form a joint.

One of the objections to the ordinary cement joint is that the sockets are likely to be burst off by the expansion of the cement, and, on the other hand, under some conditions the cement is liable to shrink and thus cause the joint to leak. This is quite true when the drains are laid by men who have not had experience enough as mechanics to know the nature of the materials they use; the same fault occurs in many other branches of the building and other trades. The answer

to the objection is that good work requires skilled workmen, whether it is drains or anything else. It is necessary, therefore, before making the joints that the nature of the cement should be ascertained; this is simply done by gauging a portion of the cement and noting the time it takes to set. If it is new and hot it will set in a few minutes, but if air slaked and cool it will take perhaps half an hour to set. When joints are made with new hot cement one must expect to get the sockets burst in some cases. But as it is a simple matter to

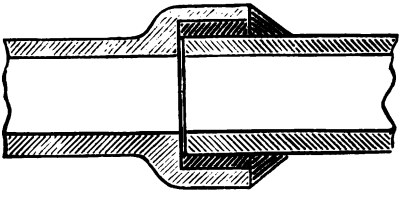


FIG. 196.

cool the cement by exposing it to the air for a few days, or if time cannot be spared, it can be killed by being gauged and allowed to nearly set and then knocked up with water again, and the second time if necessary before it is used to fill the sockets of the pipes. The best plan, however, is to fill the sockets with cool cement, and form the outer fillet as shown at Fig. 196 with fresh hot cement. By this means, although the expansion need not be feared, the joint will be quite sound, and if a little shrinkage does take place, the outside fillet, which is made with fresh cement, ensures a sound joint.

CHAPTER XXXVI.

ACCESSIBLE DRAINS.

REFERRING to my remarks in the previous chapter on the unreliable character of the jointing of stoneware drains, a case in point came under my notice recently. At a large country mansion, where the drains had been renewed during recent years, it was found on applying the water test that the whole system was leaking more or less in every section, consequently they were condemned, greatly to the surprise of the persons under whose supervision they were renewed a few years ago. When the ground was opened and the drains examined it was found that, although they were laid in fairly straight line, and some care had evidently been exercised in their construction, nearly half of the joints were unsound, and a very large number of sockets were burst by the cement. Instead of being made in the manner described in the preceding chapter, they had no concrete beneath them, the bottoms of the joints were merely bedded, and the upper part appeared to have been made in a most slipshod manner, and no attempt had been made to trowel them up. The result was that water percolated through the cement like a sieve, and ran from the bottoms in streams. And as the earth on which the drains were laid was not solid in some places, the pipes in several instances had broken right across.

Many will no doubt say that this is an argument in favour of iron drains throughout; and there is a good deal of force in the remark, for iron drains, as we shall presently

show, get over many difficulties, and are always reliable. But it must not be supposed that stoneware drains cannot be made as permanent as is necessary, when they are situated outside the walls of a house. One is frequently testing stoneware drains which have been constructed in the manner recommended in these pages, and, although it cannot be said that they are always found absolutely water-tight, the leakages, as a rule, are so insignificant as to render them unimportant. In the case of a large system of stoneware drainage at a country mansion which has been in use about six years, they were found, on testing them a few days ago,

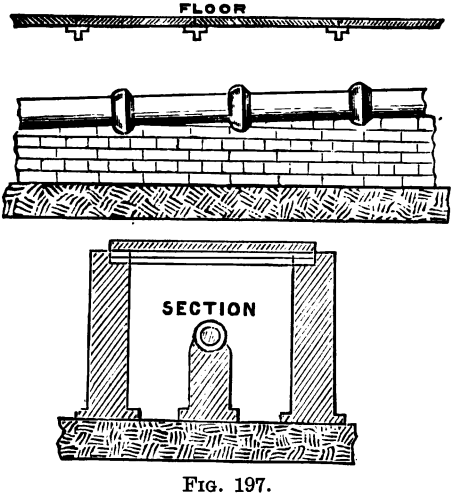


FIG. 197.

to be as tight as a bottle. The failures are, therefore, not so much due to the materials, as to the way in which they are handled by men who do not realise the nature of materials they are using. And in numerous instances they so disregard the importance of the work they are carrying out, that no amount of advice and tuition will induce them to adopt the improved methods.

In a town house, however, where the drain must of

necessity pass under the building, a leak in a drain, however small, cannot be tolerated under any circumstances, therefore an iron drain is, in most instances, the only alternative. In some cases it is possible to lay the drains in a subway which is easily accessible. In such cases, if a stoneware drain is preferred, it can be supported on a brick wall or pier, like Fig. 197 A, or on brackets, as shown at Fig. 198. The objection to the stoneware drains under these circumstances is not so forcible as it is when the drain is buried and in-

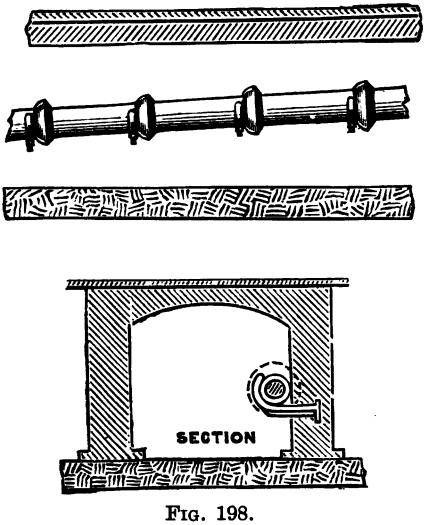


FIG. 198.

accessible, except by excavating the ground. As a matter of fact, this method of laying drains, whether they are iron or stoneware, is an excellent one, as it carries out the principle that all pipes, whether they are drains, waste pipes, or water supply pipes, should be arranged in such a way as to be easily accessible for inspection and repairs.

The subway should be practically air-tight, and ventilating pipes should be connected to each end, and terminate outside the external walls with vertical gratings, like

Fig. 199. An advantage is gained by carrying one pipe up to a considerable height, in order to induce an up draught, and so cause a current of fresh air to pass through the subway.

As these pipes do not, of course, ventilate the drains, there need be no difficulty in finding a suitable place to terminate them. In any case, however, it is best to get the upcast pipe in a position where it can get a clear blow across the top, for reasons which have already been explained in connection with soil pipe vents. It may be well to point out

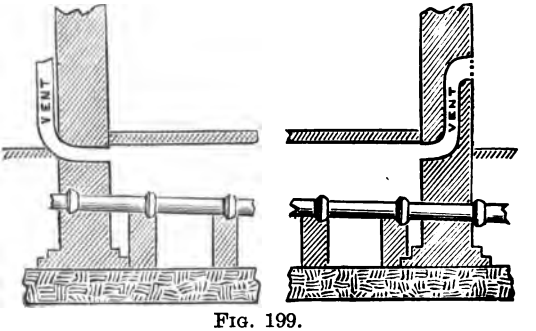


FIG. 199.

that if the drains are arranged to receive large quantities of hot water, water from condensed steam, or anything which will cause the drains to be subjected to sudden and violent variations of temperature, stoneware drains should not be used in the manner above described. And although stoneware drains, under any circumstances, will not stand violent changes of temperature without fractures, they will resist the action much better when surrounded with concrete and buried, than they will when laid without covering as above described. In such cases cast-iron pipes are the proper materials to use, without a doubt.

CHAPTER XXXVII.

IRON DRAINS.

IRON drains are more particularly adapted for fixing in subways on piers or on cantilevers pinned into walls in the manner shown for stoneware drains in the preceding chapter because they are not affected, except under some unusual circumstances, by the sudden variation of temperature when large quantities of hot water are discharged into them. Under such conditions, however, it is important that the whole system should be iron, and not, as recently described, merely in connection with brick manholes and stoneware channels. Otherwise the contraction and expansion of a long length of iron drain is likely to break the connections to the manholes. This sometimes occurs when the iron drain is surrounded with concrete and buried beneath the ground, but not so frequently as in cases where it is fixed on piers or on a wall where it is free to move one way or the other. Some will doubtless say that the surrounding concrete should not make much difference when the enormous force of expansion is considered. The fact, however, remains that it does make a good deal of difference, and in such cases it is evident that it is advisable to cover iron drains with concrete in the same manner as stoneware drains are treated when buried. But as a rule it is not considered necessary to cover the iron drains with concrete if they are laid on a bed of this material 6 inches thick. In the system of drains which we have been considering, the only part which is constructed of iron pipes is that which

passes underneath the building and, as was said at the time, this plan is very generally favoured, in London especially. The tendency, however, is to construct the whole system with iron, and thus obviate the difficulties so often experienced in the connections between stoneware and iron. There is also a growing dislike to open channels in manholes, whether the drains are of one material or the other, and as iron channels are better adapted for covers, this is another reason why iron is likely to be used universally in the future. When manholes have to be constructed inside a building, there can be no question about the advantages of

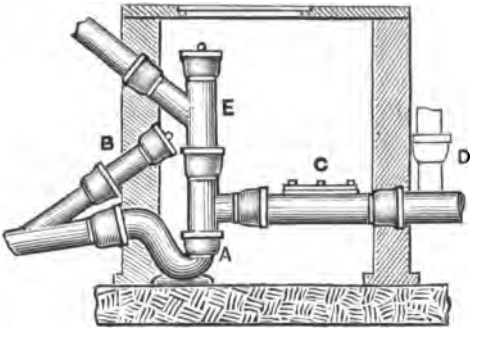


FIG. 200.

covered channels; but when they are in the open, and the channels are made deep enough, there is, in my opinion, an advantage in having the channels as accessible as possible. One objection to open channels in manholes is that drain gases accumulate at the upper part of the chambers and become stagnant. In badly ventilated drains this may be the case, but when drains are properly constructed and provided with sufficient inlet and outlet ventilators, the idea of foul, stagnant air remaining at the upper part of the chambers while there is a current of fresh air continually passing through the drains is, to say the least, somewhat unreasonable. Where manholes are constructed near the

upper ends of drains which are not provided with through ventilation, the objection is quite valid, and in such instances the best plan is to ventilate the upper part of the manhole back into the nearest upcast; or, if it is convenient, to provide an inlet ventilator. And, while one is not impressed with the alleged evils which are attributed to open-channel manholes, it is not contended that upper parts of these chambers, particularly where they are very deep, should not be ventilated by a branch pipe taken into the nearest upcast, where such a plan is possible, on the principle that the more ventilation that can be provided the better from every point of view.

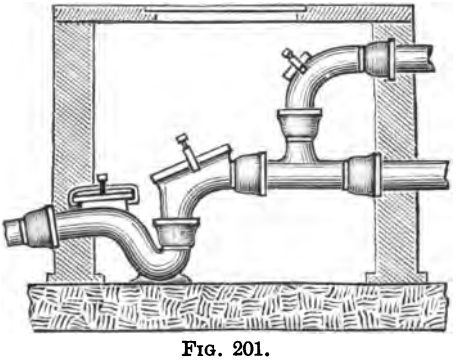


FIG. 201.

With regard to the fittings required for iron drain construction, these have been greatly improved upon during recent years, both in form and character. The first fitting which has to be considered is the disconnecting trap. In its simple form it can be arranged as shown at Fig. 200. This shows an iron trap (A) of the ordinary form in connection with a Y junction (B) on the outlet for giving access to the drain towards the sewer, and an inspection eye (C), the cover of which can be removed when the house drain requires attention. One does not advise such an arrangement in preference to a fitting with most of these features combined, such, for instance, as that shown at Fig. 201, and although

the air-inlet pipe is not so favourably situated, it is provided with an access eye for cleaning. But in some cases, where it is difficult to get the proper fitting, it is necessary to do the work with the fittings nearest to hand, and, although not so compact and neat, will answer the purpose, at any rate from a sanitary point of view.

The fresh-air inlet pipe is sometimes formed by a right-angle junction on the top of the inlet drain, as shown by the dotted lines D, but in this position there is a possibility of its becoming stopped up by floating greasy matters if the drain becomes temporarily stopped up and it is inaccessible for cleaning. But if it is connected by a short junction to the inlet shaft of the trap E, it is placed at a higher level, and on removing the stopper in the top of the shaft it can be cleaned out when required. The junction B can be turned over a little on one side to miss the air-inlet junction. Where the drain can be fixed in a subway or on a wall of a cellar, a manhole is not required, as the whole fitting can be quite air-tight. But when the drain is buried beneath the ground an access manhole should be built around the trap and fittings, as shown in the sketch, and fitted with an iron or other suitable cover, which need not be air-tight, level with the surface of the floor.

Although the many advantages which are claimed for iron drains and bolted-down covers to channels are, for the most part, beyond dispute, there are, however, some disadvantages which the out-and-out advocates of cast iron, as against stoneware, are rather slow to recognise. My own experience is that well-constructed manholes with stoneware channels, where the branches discharge over the side of the main channel, and the branch drains join the manhole at suitable angles, have a decided advantage over the iron channels, inasmuch as the former are found to remain much cleaner than the latter.

The reason is that the iron branches join the main channel nearly at the same level, and the angles at which they are connected in nearly all cases do not have the effect of turning the direction of the flow of the sewage to any appreciable extent before it reaches the main channel. The result of this is that when two or more branches join one manhole, when one is in use, there is always a back wash up the other branch drains. A case in point came under my notice recently. An iron manhole, to which was connected two branch drains, one on each side, had to be frequently opened in order to remove a stoppage from one

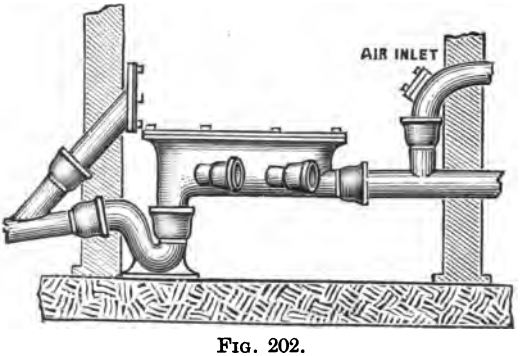


FIG. 202.

of the branch drains. One of the branches was connected to a flush-out grease gully, to which was fitted an automatic flushing tank discharging about thirty gallons of water twice a day; the other branch was in connection with water-closets and sinks, and was fitted with a flushing tank at its upper end. It was this branch drain which was continually stopping up, notwithstanding the discharge of fifty gallons of water once a day. Upon investigation it was discovered that when the flushing tank in connection with the scullery grease gully discharged, owing to the obtuse angle at which the branch drain was connected to the main channel, a large part of the greasy water washed back up the other drain, and caused an

accumulation of grease and sand which the fifty-gallon flushing tank could not clear away. And as the house was occupied something had to be done to remedy the defect quickly. The iron channels were therefore cut out and replaced by glazed stoneware, and the grease gully branch connected at an acute angle, well above the bottom of the main channel, with a satisfactory result, as the wash back up the opposite branch drain was hardly noticeable. It is not denied that the manhole could have been reconstructed in cast iron, but it would have involved a special casting,

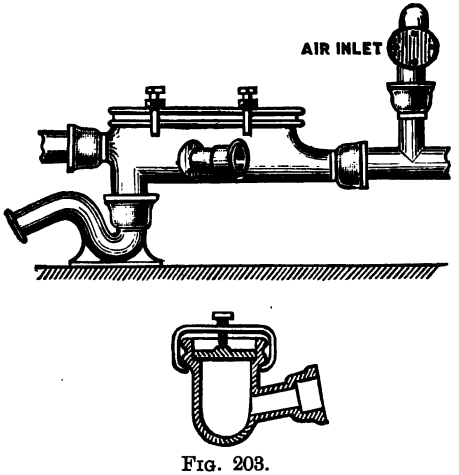


FIG. 203.

which would have been very expensive and difficult to connect to the existing drains in a proper manner. As a matter of fact, the iron manhole which was removed was made specially for the job, as a difficulty was anticipated in the first place. But it is generally found that when a special kind of fitting is required, the drawing is to a great extent ignored, and the existing patterns and moulds worked in as near as is possible to suit the fitting. The result is a useless modification of the stock patterns.

Other cases of a similar kind have occurred where the

circumstances are quite different. It often happens that one branch drain is in connection with a gully receiving the waste water from a small sink or lavatory basin, or perhaps a rain-water pipe, and the branch on the other side is connected to a soil pipe conveying discharges from second or third floor closets. Consequently the velocity of the discharge from the soil pipe branch is sufficient to force the liquid and solids some distance up the opposite drain, where a deposit is being continually left, and which the small discharge from the sink or rain-water pipe is not powerful enough to dislodge. The ultimate result is a very foul drain and a stoppage upon which, as already pointed out in a previous chapter, the flushing water through the main drain has no effect.

It is important, therefore, when constructing iron drains, and stoneware drains too, for that matter, to keep these points in mind. When one or more branch drains are required in the disconnecting manhole a fitting similar to Fig. 202 is one of the kind used for the purpose. The channel, it will be seen, has a vertical spigot at the lower end for connecting to the trap. In this case the air inlet pipe must be connected by a right-angle junction, as shown, and the access to the drain on the sewer side is also made by a junction having a bolted plate on the end inside the manhole. This cover is bolted down, but that shown at Fig. 203 is secured with a bridle and screw. This also has a connection in the end over the trap and is sometimes used as an air inlet, but as it is likely to get stopped with sewage, it should not be used for this purpose. It may, however, be used for connecting a drain from a gully which is well flushed at frequent intervals, and so will prevent the accumulation of deposits which is most likely to occur under ordinary circumstances.

CHAPTER XXXVIII.

IRON JUNCTIONS.

IT is a generally recognised rule in the arrangement of modern drainage that all branch drains should join the main line of drains at an inspection chamber—in other words, all junctions should be fitted with inspection eyes. This rule is not always carried out, because it would be found in many cases to involve so many manholes, and that the necessary expense could hardly be justified. Some judgment

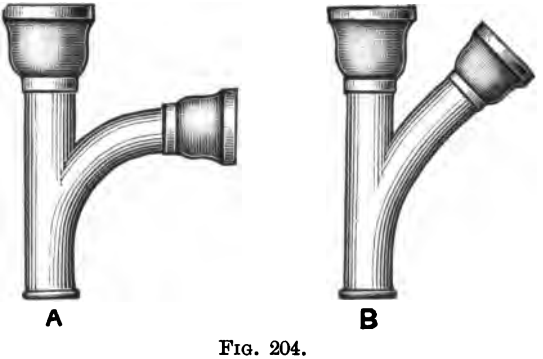


FIG. 204.

has therefore to be exercised in placing the manholes in the most suitable positions.

It is important that all junctions in connection with soil pipes and water-closets, where solid matters have to pass, should be easily accessible. It is also advisable to provide access to junctions which are in connection with scullery and pantry sinks, or similar fittings from which a large amount of greasy water is discharged. But branch

drains which receive nothing but bath, lavatory, or rain water may with safety be connected to the main drain by means of ordinary junctions, providing they are of the form shown at Fig. 204, which joins the main drain at an acute angle.

Although this applies to both earthenware and iron drains, it is more especially important when the whole of the system is constructed of cast iron.

One does not, of course, anticipate any serious stop-

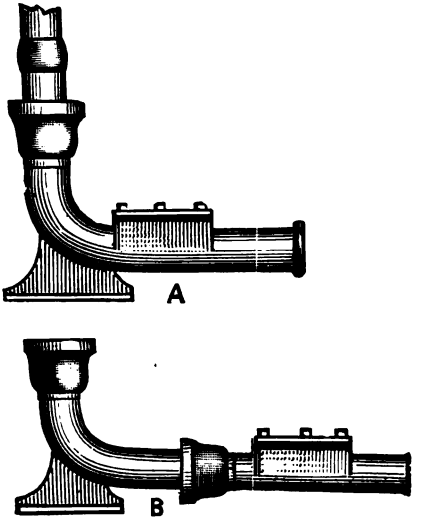


FIG. 205.

pages in well constructed and properly arranged drainage systems, and as a matter of fact they very seldom occur. But none can be regarded as absolutely perfect, notwithstanding the very careless way the word "perfect" is made use of in describing the drainage of houses. Of the two, however, iron drains should be made more accessible, owing to the difficulty experienced in opening any part of the drain in the case of necessity.

A stoneware drain can easily be exposed and tapped

in most instances, and, if carefully done, can be safely repaired, but the opening of an iron drain is much more difficult, and if the stoppage is caused by a defect in the casting of the junction, as is likely to be the case, the proper remedy runs into a big job. This calls to mind one of the cases in my own experience, where a stoppage occurred in an iron drain at the foot of a soil pipe; and so firm was the obstruction that the filling of the soil pipe with water up to the second-floor water-closet did not produce enough pressure to remove it. The manhole at the junction did not give sufficient access to remove the stoppage.

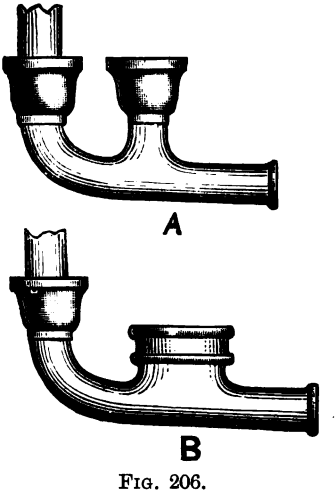


FIG. 206.

An opening was made in the lead soil pipe just above the "duck's-foot" bend to which it was connected, but this was of no use. The paving was then taken up, the concrete covering removed, and two holes were drilled in the iron drain just at the spot where the obstruction existed.

It was then possible to get at the cause of the trouble, which was found to be a large towel. The primary cause was doubtless a roughness in one of the caulked joints, to which the towel clung, and then it crinkled up and formed into a hard plug, which was very difficult to remove. The towel by some means must have been passed through one of the water-closets, but how, it could not be ascertained. If one had nothing but the ordinary composition of sewage to deal with there would be very little difficulty, but when towels, scrubbing-brushes, hair-pins, tooth-brushes, and various other domestic utensils have to be provided for,

there can be no doubt that all branch drains to soil pipes should be fitted with access eyes on the bends of a kind similar to that shown at Fig. 205 A, or if they cannot be obtained that shown at B will answer the purpose. The fitting shown at A does not appear to have been made yet, but there is no reason why it should not, as it would be very useful in many instances where soil-pipes are connected to long branch drains.

There are, however, some access bends made of the form shown at Fig. 206 (A and B), which, in the absence of the form shown at Fig. 205, are useful for fixing at the feet of rain or soil pipes.

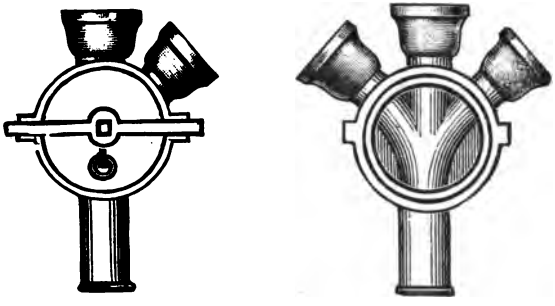


FIG. 207.

Where one or two branch drains join the main drain the access junctions shown at Fig. 207 are useful for the purpose. The covers, which are secured with a bridle, are made air-tight by a grease joint or some suitable form of packing that will not set too hard. Sometimes red lead putty is used, and this is all very well as a reliable packing, but the difficulty is to remove the cover after it has been bedded down for a year or two.

A rubber ring packing answers the purpose if it is periodically attended to, but if it is left for a long time it acts as a cement and adheres firmly to the iron and renders the cover almost immovable.

A washer of thick felt, saturated with tallow, makes a good joint, but it requires renewing every three or four years. A great improvement would be effected in these iron junctions if the channel were brought up to the level of the cover, as

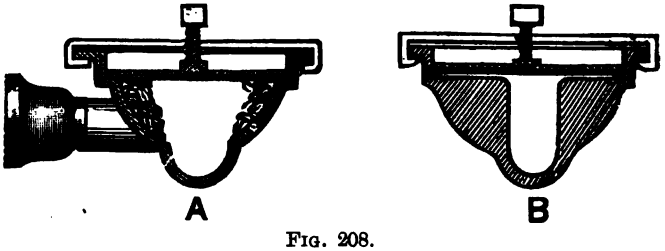


FIG. 208.

shown at the section Fig. 208 A, instead of the space being left vacant as is at present the case like that shown at B. There would then be no space for the accumulation of solid matter.

THE END.

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